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Concepts of Driver Education and Their Relative Importance for a Driver Education Course in the Secondary School[1]

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Abstract

The purpose of the study was to determine fundamental concepts for classroom instruction of driver education and their relative importance for a course at the secondary level. The 295 concepts obtained from textbooks, state courses of study, and the periodical *Safety Education*, were submitted to authorities for validation. The resulting 210 concepts were evaluated by law enforcement officials, teachers of driver education, and driver education students. Coefficients of correlation indicated general agreement between the rating groups. Concepts were ranked in descending order of importance.

SINCE the close of World War II, driver education has been one of the most rapidly expanding areas in education within the United States. As sometimes happens during periods of rapid growth, the emphasis in this field has been on getting the job done, i.e., teaching students to drive. Of necessity, some of the finer points such as greater uniformity of curriculum content, certification of teachers, and development of subject matter have received less attention. Although much material is available and recommendations for course content have been outlined (17, *p. 27-31*), a determination of fundamental concepts essential to the driver education curriculum has not been undertaken.

Nature of the Problem

The purpose of this study is to determine objectively, and rank in the order of their importance, those concepts of the classroom phase of driver education which are of fundamental value for a course at the secondary-school level.

The need for driver education is obvious whenever one observes the behavior of motor vehicle drivers and pedestrians on our highways and streets. Since the first gasoline-engine automobile in the United States, there has been a steady increase in the use of motor vehicles and the need for trained

[1] This study was carried out in partial fulfillment of the requirements for the Doctor of Education degree in the School of Education, Boston University, under the direction of Dr. Leslie W. Irwin.

persons to operate them. Many schools have included driver education in the curriculum.

As a prerequisite for the most effective teaching, Billett stresses the need for "the identification of the concepts and skills which are essential to, or consistent with, successful, happy and socially desirable behavior in a democracy." (3, *p. 150*). Further recognition of the value of determining basic concepts is apparent in the recommendations of the National Society for the Study of Education (18) and the classic Report of the Harvard Committee (12).

Definition of Terms

Concept. For the purposes of this study the term concept shall be interpreted as meaning those "understandings based upon related groups of facts and opinions that increase a person's ability to deal efficiently and effectively with certain aspects of his environment." (6, *p. 145*)

Driver education. Throughout this report driver education will signify "all those learning experiences provided by the school for the purpose of helping students to learn to use motor vehicles safely and efficiently." (17, *p. 7*)

Classroom instruction. The term classroom instruction as used in this report refers to "those learning experiences which are provided elsewhere than in a motor vehicle." (17, *p. 7*)

Secondary school. In this discussion the term secondary school refers to grades ten through 12 inclusive.

Review of the Literature

A review of literature shows little research of an objective nature concerned with subject matter in the classroom instruction of driver education. A brief summary of those investigations which are concerned with related problems is given here.

In 1937 Anselm (2) studied the errors of judgment which lead children and young drivers into hazardous situations in highway traffic. Typical accident situations were determined by analyzing 700 motor vehicle collisions. The findings were placed into 18 categories, and test forms were prepared to show these situations both verbally and through drawings.

Brody (5) in 1941 analyzed the personal factors involved in the problem of traffic accident prevention, as related to driver licensing standards and procedures, driver education and guidance, and driver equipment procedures, to determine the need for further investigation in these areas.

In the same year Siebrecht (21) constructed a scale for the measurement of attitudes toward factors considered important in operating a motor vehicle safely.

Strasser (7, *p. 55*) proposed to develop a manual that would make easily available a program of practices and procedures which would be helpful to

fleet owners and supervisors in the development of safer and more efficient fleet operation through the control of the human factor—the driver.

A study by Florio (10) resulted in an outline or guide to assist teachers in organizing, presenting, and administering courses in driver education. There was no attempt made, however, to offer a detailed program; content was merely suggested.

In 1941 Wise (25) investigated the relative importance of principles of physical science for general education, and in 1944 Martin (15) conducted a similar study in the biological sciences. A series of research studies concerned with concepts in health instruction at the elementary, secondary, and college levels were conducted by Staton (23), Boyd (4), and Merrill (16).

During the past decade many groups have undertaken to study the results of the fast-growing driver education program. The American Automobile Association (1) has summarized all known studies on the result of driver education.

Logical Analysis

The study was divided into two major phases: 1. The determination of concepts of driver education which might serve as a basis of classroom instruction for a course in driver education at the secondary school level, through a careful analysis of textbooks, periodicals, and state courses of study; and 2. The determination of the validity and relative importance of each concept in terms of its suitability as a unit, or component part of a unit, of driver education at the secondary school level.

Research Procedure

PHASE ONE

In order to obtain a valid list of concepts of driver education, it was necessary to survey a number of materials which might provide such concepts. After examining the materials, the investigator decided that the textbooks and state courses of study written for use at the secondary level, and the magazine *Safety Education* afforded the most authoritative sources of concepts in driver education.

Sub-Problem 1. The investigator made a page by page analysis of seven textbooks. Each statement which satisfied the definition of a concept was written on a file card together with the source. The cards were arranged under topical headings similar to the content areas for a driver education course as suggested by the National Commission on Safety Education (17, *p. 20*), and Brody and Stack (6, *p. 72-75*).

The textbooks used in this part of the investigation were:

American Automobile Association. *Sportsmanlike Driving* (2nd ed.). Washington 6, D. C., 1948.

Brody, Leon, and Herbert J. Stack, *Highway Safety and Driver Education.* New York: Prentice-Hall, Inc., 1954.

Center for Safety Education, New York University, *Man and the Motor Car* (5th ed.). New York: Prentice-Hall, Inc., 1954.

HALSEY, MAXWELL. *Let's Drive Right.* Chicago: Scott, Foresman, and Co., 1954.
STACK, HERBERT J., ELMER B. SIEBRECHT, and J. DUKE ELKOW. *Education for Safe Living* (2nd ed.). New York: Prentice-Hall, Inc., 1949.
TYSOR, H. JAMES, *The Fundamental Principles of Driving.* Dallas: Banks Upshaw and Co., 1953.
WHITE, ERNEST B, *The Road to Better Driving.* New York: Cambridge Book Co., 1955.

Sub-Problem 2. State courses of study for driver education were read and analyzed in the same manner used to secure statements from the textbooks. The recording procedure used in completing sub-problem 1 was also employed. The state courses of study used were:

ARIZONA HIGHWAY DEPARTMENT, Traffic Safety Division. *A Guide for Driver Education.* 1955.
CALIFORNIA STATE DEPARTMENT OF EDUCATION. *Driver Instruction: A Guide for Driver Education and Driver Training.* 1953.
AYARS, GEORGE W. *A Guide for Driver Education for the Secondary Schools of Delaware.* State of Delaware, Department of Public Instruction, Bulletin 77-51, Wilmington: William N. Cann, Inc.
KENTUCKY DEPARTMENT OF EDUCATION, Commonwealth of Kentucky, *Highway Safety and Driver Education.* Education Bulletin, Vol. 21, No. 3, May, 1953.
NEW YORK STATE EDUCATION DEPARTMENT, *Driver Education: Syllabus for Secondary Schools.*
NICKELL, VERNON L., Superintendent of Public Instruction, *The Illinois Syllabus in Driver Education and Training for High School Administrators and Teachers,* Circular Series A, No. 37, State of Illinois, Springfield, 1946.
MORRILL, RADCLIFFE, Chairman, *The Massachusetts Standard Outline with Selected Material for Instructors in Driver Education,* Registry of Motor Vehicles of Commonwealth of Massachusetts.
OHIO STATE DEPARTMENT OF EDUCATION, *Driver Education and Training in the Secondary Schools of Ohio* (rev. ed.). Columbus: Heer Printing Co., 1948-49.
THURSTON, LEE M., Superintendent, Department of Public Instruction, *They're Going to Drive.* Bulletin No. 352, Lansing, Michigan, 1951.
WEST VIRGINIA STATE DEPARTMENT OF EDUCATION. *A Course of Study in Driver Education for West Virginia Schools* (rev. ed.), 1951.

Sub-Problem 3. Thirty-six issues of *Safety Education* were surveyed and analyzed. The same procedure as employed in completing sub-problems 1 and 2 was used here with regard to analysis, selection, and recording of the concepts.

Sub-Problem 4. All of the concepts tentatively selected were rechecked to make certain they had been categorized correctly. Each of the concepts was then studied and analyzed in the light of the following criteria, previously established in similar studies (4, *p. 182*; 16, *p. 427*):

1. The statement must be a comprehensive generalization or part of a comprehensive generalization.
2. The statement must not be a definition.
3. The statement must be true without exceptions within the limitations specifically stated.
4. The statement must be stated definitely or clearly implied in the writings of the author.

Duplications were then eliminated, related ideas combined, and the wording improved wherever necessary. Similar and related generalizations were combined, or grouped together by the process of telescoping, which is recognized by Charters (8, *p. 75*) as an effective method of handling such data. Rewording consisted mainly of eliminating unnecessary words, careful attention being given to the preservation of context.

A list of 295 concepts for classroom instruction in driver education was obtained by the procedure described in sub-problems 1, 2, 3, and 4 of phase one of the study.

PHASE TWO

In order to determine the validity and relative importance of each concept, the list of concepts resulting from phase one was submitted to a group of authorities on driver education, driver education teachers, law enforcement officials, and secondary school students who had completed a course in driver education.

Sub-Problem 1. The validity of the concepts was established by submitting the list of 295 concepts to a group of authorities in the field of driver education. The following instructions were given:

> Please read the following list of concepts with these specific criteria in mind:
>
> ARE THESE CONCEPTS ACCURATE AND CONSISTENT WITH CURRENT AND ACCEPTED DRIVER EDUCATION PRACTICE AND RESEARCH?
>
> Any concept which does not meet the criteria should be crossed out.
>
> If any of the concepts should possibly appear to be duplicated in meaning although the wording is different, please so indicate by crossing out the more poorly written concept and writing beside it the number of the other concept involved.

The jurors for validation were selected on the basis of their leadership, writings, participation in driver education study and research, and their contribution to such organizations as the 1953 National Conference on Driver Education and the 43rd National Safety Congress. This group included:

Loren D. Campbell, Director of Driver Education, State University of New York, State Teachers College, New Paltz, N. Y.

T. A. Carmichael, Coordinator of Safety, State Department of Education, Atlanta, Ga.

Price E. Clark, Education Director, Accident Prevention Department, Association of Casualty and Surety Companies, New York, N. Y.

J. Duke Elkow, Professor, Department of Health and Physical Education, Brooklyn College, Brooklyn, N. Y.

Eugene Fanning, Supervisor, Driver Education and Driver Training, Registry of Motor Vehicles, Boston, Mass.

Harry D. Fletcher, Institute of Public Safety, Pennsylvania State University.

A. E. Florio, Assistant Professor of Physical Education, School of Education, University of Illinois.

G. Challis Franklin, Supervisor of Secondary Education, University of the State of New York, State Education Department, Albany.

James J. Griffin, Coordinator of Safety, Board of Education, Chicago, Ill.

Z. E. Helms, Chief, Driver Training Section, State Department of Motor Vehicles, Raleigh, N. C.

A. E. Houk, State Inspector, Motor Transport Training, University of Alabama, Tuscaloosa, Ala.

Joseph Intorre, Institute of Public Safety, Pennsylvania State University.

Harold K. Jack, Supervisor, Health and Physical Education, Safety and Recreation, State Board of Education, Richmond, Va.

Dalibor W. Kralovec, Assistant Director-in-Charge-of-Safety, School District of Philadelphia.

Paul E. Landis, Supervisor, Health, Physical Education, Recreation and Safety, State Department of Education, Columbus, Ohio.

Charles Lemmel, Supervisor of Driver Education, State Department of Public Instruction, Dover, Del.

Samuel P. Messer, Director of Safety Education, University of Miami, Coral Gables, Fla.

Richard J. O'Conner, Supervisor, Driver Education, Board of Education of the City of New York, Brooklyn.

Ronald D. Patterson, Supervisor, Safety Education Department, Detroit Public Schools.

Ira B. Rogers, Jr., Education Division, Automotive Safety Foundation, Washington, D. C.

Melvin Schroeder, Supervisor, Driver Instruction, Los Angeles City Schools, Los Angeles, Calif.

T. A. Seals, Assistant Education Director, Accident Prevention Department, Association of Casualty and Surety Companies, New York, N. Y.

Leslie R. Silvernale, Coordinator of Driver Education, Continuing Education Service, Michigan State College.

Lewis Spears, Consultant in Safety Education, Texas Education Agency, Austin.

Charles W. Stark, Secretary, National Committee on Uniform Traffic Laws and Ordinances, Washington, D. C.

Ivan J. Stehman, Chief, Highway Safety Education, State Department of Public Instruction, Harrisburg, Pa.

Ralph Thomas, Institute of Public Safety, Pennsylvania State University.

Charles D. Vibberts, Director, Safety and Education, Ohio State Automobile Association, Columbus, Ohio.

H. E. Williamson, State Consultant on Driver Education and Safety, Florida State Department of Education.

Bert L. Woodcock, Director of Safety Education, Iowa State Teachers College, Cedar Falls, Iowa.

Cecil G. Zaun, Supervisor of Safety, Los Angeles City Schools, Los Angeles, Calif.

The investigator re-examined those concepts which the jury indicated did not meet the criteria and those in which rewording was suggested. As a result of this re-examination, a revised list of 229 concepts was developed.

To determine further the validity of the concepts included in the revised list, they were then submitted to a second jury. The criteria for the selection of this jury were the same as those used for the first jury. Members of the second jury were:

Edward R. Abramoski, Coordinator of Elementary Physical Education, Health and Safety, Public Schools, Erie, Pa.

Homer Allen, Associate Professor of Physical Education, Purdue University.

Frank Bennett, Specialist in Safety Education, Baltimore City Public Schools, Baltimore, Md.

Richard W. Bishop, Associate Professor Health and Safety, State Teachers College, Millersville, Pa.

A. Frank Bridges, Assistant Professor of Health Education, Southern Illinois University.

RUSSELL BROWN, Iowa Department of Public Safety, Des Moines, Iowa.
C. WESLEY DANE, Director of Driver Education, Indiana State Department of Public Instruction, Indianapolis.
A. D. FLORENCE, Assistant Supervisor of Safety Education, Public Schools, Toledo, Ohio.
A. E. FLORIO, Associate Professor of Safety Education, School of Physical Education, University of Illinois.
NORMAN KEY, National Education Association Safety Commission, Washington, D. C.
ALFRED T. LITTLE, Supervisor of Safety Education, Registry of Motor Vehicles, Boston, Mass.
GEORGE P. MATHIS, Assistant Superintendent, Health and Physical Education and Safety, State Department of Public Instruction, Springfield, Ill.
F. R. NOFFSINGER, Traffic Institute, Northwestern University.
HARLAN RIEBE, Department of Health Education, Eastern Illinois State College, Charleston, Ill.
DON CASH SEATON, Head, Physical Education Department, University of Kentucky.
ELMER B. SIEBRECHT, Professor Psychology, Seattle Pacific College, Seattle, Wash.
PAUL J. VAN HORN, Professor of Industrial Arts, Southwestern Louisiana Institute, Lafayette, La.
PAUL G. WARREN, Supervisor of Driver Education, Office of Secretary of State, Salem, Oregon.

In validating the concepts, items were retained if 75 per cent or more of the jurors considered them accurate and consistent with current and accepted driver education and research. Wherever rephrasing and/or substitution of words had been suggested by the jurors, the writer considered such proposals carefully. If the meaning of the concept could be preserved and yet made clearer by such a change, the change was made. The 210 concepts which remained were therefore considered to meet the criteria of being accurate and consistent with correct and accepted driver education knowledge and research.

Sub-Problem 2. The next consideration of the study was to determine the relative importance of each concept as the basis for a unit, or component part of a unit, for classroom instruction in a driver education course at the secondary-school level. This involved submitting the list of 210 concepts to three groups:

1. Forty-nine teachers of driver education.
2. Twenty-six law enforcement officials.
3. One hundred eighty-five secondary-school students who had completed a course in driver education.

Geographically, teachers and students were used from 27 Massachusetts and 22 Illinois schools. Participating law enforcement officials represented 14 states and ten major cities.

All persons who served as raters were given the list of concepts with the following instructions:

Read the following instructions carefully.

The purpose of this form is to determine what information YOU feel should be included in a driver education course for high school students.

Please read each statement carefully. Then indicate your feelings about it by encircling the appropriate number according to the following plan:

	Essential	Desirable	Unnecessary
If *YOU* believe the statement is ESSENTIAL and should be included in every driver education course, Circle	(3)	2	1
If *YOU* believe the statement is DESIRABLE, and should be included if possible, Circle	3	(2)	1
If *YOU* believe the statement is UNNECESSARY and may be omitted, Circle	3	2	(1)

Sub-Problem 3. The third sub-problem of phase two was concerned with the handling of the data obtained in completing sub-problems 1 and 2, in order to place the concepts in descending rank order of importance.

The use of percentages appeared to be an effective method for determining the descending rank order of importance of the concepts. This method also appeared to indicate clearly how the raters felt as to the relative importance of each concept.

An item analysis was made to determine the number of raters who evaluated each concept as being essential, desirable or unnecessary. From the results of the tabulation, the percentage of raters within each rating group who evaluated a concept as being essential was computed. Percentages for each concept were also determined for the other two values, i.e., desirable and unnecessary.

To determine the rank order by each rating group, the concepts were arranged in descending order according to the per cent of raters indicating the concept as essential. Wherever more than one concept was rated essential by the same percentage of raters, the percentage rating for the desirable value was used to determine the position in the descending order. After all of the concepts had been arranged in descending order, each was assigned a rank from one to 210. Tables resulting from this procedure were constructed to show the descending rank order of the concepts by each rating group.

After the concepts were ranked in descending order of importance by the three rating groups, the relationship between the rank orders was determined by the Spearman rank order coefficient of correlation method. Correlations, using rank differences, were found to be as follows: the coefficient of correlation between the rank order by enforcement officials and the rank order by driver education teachers was .86, S.E. $\pm$ .02; the coefficient of correlation between the rank order by the officials and that of secondary-school students who had completed a course in driver education was .73, S.E. $\pm$ .03; and the coefficient of correlation between the rank order by the teachers and that of the students was .87, S.E. $\pm$ .02. All three coefficients are sufficiently high to be significant.

The rank order in importance of the topical areas was determined according to the number of concepts rated essential under each topical heading.

As the final phase of this thesis, all raters were considered as one group and the ratings were re-analyzed. The same procedure used to ascertain the individual group rankings was also employed in this determination of the rank order of the concepts by all 260 raters.

Findings

The findings of the study are presented in six tables, as follows:

1. Concepts Ranked in Order of Importance by Law Enforcement Officials—Ratings Expressed in Percentages
2. Concepts Ranked in Order of Importance by Driver Education Teachers—Ratings Expressed in Percentages
3. Concepts Ranked in Order of Importance by Students—Ratings Expressed in Percentages
4. Correlations for Rank Order of Concepts by Rating Groups Using Rank Differences
5. Relative Importance of Topical Areas Determined by Proportion of Concepts Rated Essential by Officials, Teachers, and Students
6. Concepts Ranked in Order of Importance by Officials, Teachers, and Students—Ratings Expressed in Percentages

Because of limited space only Table 6 is presented in this study.

Summary

The purpose of the study was to determine fundamental concepts for classroom instruction of driver education and their relative importance for a course at the secondary level.

The study was divided into two major phases, the first consisting of an analysis of selected textbooks, state courses of study, and 36 issues of *Safety Education* to obtain a list of concepts of driver education suitable for use at the secondary level. Phase two was concerned with determining the validity and relative importance of each of the 295 concepts obtained in phase one. Validity was established by submitting the list to a group of authorities in the field of driver education. Concepts indicated by the jury as inaccurate were eliminated. The 210 items retained were considered by 75 per cent or more of the jurors to be accurate and consistent with current and accepted driver education practice and research.

Relative importance of the concepts was determined by submitting them to 26 law enforcement officials, 49 driver education teachers, and 185 secondary-school students. Based on the per cent of raters indicating a concept as essential, desirable or unnecessary, the concepts were ranked in descending order of importance by each group. Coefficients of correlation computed by the Spearman rank order method indicated an unanimity of agreement between the three rating groups. Finally, all raters were considered as one group and the concepts ranked in descending order of importance.

Conclusions

Within the limitations of this study, sources of material and the method utilized, it would seem that the following conclusions drawn from the findings may be considered sound:

1. The list of 210 concepts of driver education evolved from this study are accurate and consistent with current practice and research.

2. The 154 concepts rated "essential" by 50 per cent or more of the total rating group should be included in the classroom instruction phase of the driver education course in the secondary school.

3. Of the remaining 56 concepts, it would appear that since only one was rated "unnecessary" by 50 per cent or more of the total rating group, 55 concepts may be considered "desirable" and should be included in the classroom instruction of driver education if time permits.

4. The high coefficients of rank correlation between the three rating groups indicates a marked relationship, or unanimity of appraisement, as to the relative importance of the concepts.

Implications of the Study

From a survey of available published research in driver education directly related to the determination of course content, it would seem significant that there are no previous studies concerned with determining concepts of classroom instruction in driver education founded on objective methods of research.

The core of driver education concepts determined by this research may prove valuable to: (a) secondary-school teachers of driver education; (b) persons, committees, or councils concerned with curriculum construction or revision; (c) individuals conducting research in driver education; (d) authors of textbooks, courses of study, or other teaching materials; and (e) college instructors concerned with teacher training in driver education.

For the persons or groups mentioned above, the list of concepts may well indicate to some extent the amount of time and emphasis which should be given to these concepts. It is conceivable that teaching all the concepts may present a problem to the driver education teacher in the average secondary school. It should be pointed out, therefore, that the teacher will, in most instances, select those concepts from the upper ranks of the list which best fit the needs of his particular situation.

Although it is hoped that knowledge and understanding of these fundamental concepts will contribute to safe and efficient driving, it cannot be assumed that the individual will be a better driver unless he adopts the proper attitude and willingness to use this knowledge.

Recommendations for Further Study

During the consideration and study of this research, certain related prolems became evident as being worthy of further investigation:

1. A determination of the fundamental concepts of the driving or behind-the-wheel phase of driver education.

2. A comparison of the concept ratings made by parents with the ratings obtained in this study.

TABLE 6[1]

Concepts Ranked in Order of Importance by Officials, Teachers and Students—Ratings Expressed in Percentages

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
1.	Passing near the crest of a hill, on a curve, or at an intersection is extremely dangerous.	95.8	3.8	.4
2.	A sound driver possesses good attitudes, habits, and emotional control which contribute to driving efficiency.	94.2	4.6	1.2
3.	Under most circumstances a driver should not leave the scene of an accident until all legal responsibilities have been fulfilled.	93.5	6.1	.4
4.	Hand or automatic signals should be given decisively and soon enough to give any person affected ample warning.	93.4	5.8	.8
5.	Increasing traffic volume requires more carefully trained drivers.	93.0	6.6	.4
6.	School bus laws in most states prohibit cars from passing in either direction when a school bus stops to load or unload children on the highway.	92.3	6.9	.8
7.	Speed at night should be lower than during the day because visibility distances are reduced.	91.1	8.5	.4
8.	When the car skids, the driver should avoid using the brakes, turn the front wheels into the direction of the skid, and mildly accelerate the engine so that friction may be increased on the rear wheels.	91.1	8.1	.8
9.	Systematic driving instruction is better than a "trial and error" method of learning to drive.	90.4	8.5	1.1
10.	The consumption of alcohol impairs vision, judgment, muscular co-ordination and efficiency, and reduces accuracy and speed of reaction.	90.4	7.7	1.9
11.	Speed must at all times be reasonable and proper, having regard for traffic, the use of the way, and the safety of the public.	89.6	9.6	.8
12.	The driver, unless seriously injured, is responsible for reporting to proper authorities damage or personal injury caused by him or his car.	88.4	10.8	.8
13.	In slowing down or stopping where conditions threaten skidding, one should gently brake, keeping the clutch engaged until the car is almost stopped.	88.1	10.8	1.1
14.	A good driver will depress his headlight beam when meeting other cars.	87.7	12.3	
15.	Good drivers, regardless of their reaction time, are careful to keep an adequate braking distance clear ahead of them.	87.7	10.8	1.5
16.	When it is necessary to stop along the highway, the car should be pulled off the pavement.	87.6	10.8	1.5
17.	A driver should be willing to yield his own rights in the interest of safety.	87.3	11.9	.8
18.5	Drivers and pedestrians must be familiar with traffic laws and regulations to help insure their safety in traffic.	87.3	12.3	.4
18.5.	Motorists are required by law in most staets to yield the right of way to pedestrians.	87.3	12.3	.4
20.	Driving is a privilege, not a right.	86.5	12.7	.8
21.	In leaving the car parked parallel on an upgrade, the hand brake should be set and the front wheels should be turned away from the curb with the rear of the right front tire touching the curb.	86.1	13.5	.4
23.	Education of the modern driver should include the development of attitudes of responsibility, sportsmanship, and courtesy.	85.4	13.5	1.1

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
23.	Fatigue affects mental alertness and muscular co-ordination while driving a car.	85.4	13.5	1.1
23.	For safety when driving through an intersection, one should slow down, glance left and then right, in approaching the intersection.	85.4	13.5	1.1
25.	Stopping to rest is better practice than taking drugs in order to avoid fatigue in long hours of driving.	84.6	14.2	1.1
26.	The driver's following distance behind another vehicle should vary with conditions of the road, weather, time of day, and density and speed of traffic.	83.6	15.0	1.9
27.	Stopping distances are much greater than is generally believed.	83.5	13.5	3.0
28.	Accident potential increases as speed increases.	83.1	12.3	4.6
29.	The choice of a safe speed in traffic is a speed so controlled that the vehicle can be brought to a full stop before striking any obstruction, whether vehicle or pedestrian.	82.3	15.8	1.9
30.	An understanding and acceptance of traffic laws and regulations, traffic signs, signals, and markings help to develop an attitude of respect for law enforcement and observance.	82.3	15.4	2.3
31.	Pedestrians stepping into the street from between parked cars are one of the most serious hazards to city driving.	82.3	14.2	3.5
32.	Proper attitudes contribute considerably to the development of a good driving personality.	81.9	16.2	1.9
33.	The wise driver makes sure he has adequate insurance protection.	81.5	17.0	1.5
34.	The driver's seat should be adjusted so that when he looks straight ahead he will be looking over the top of the steering wheel and will be able to reach the accelerator pedal and brake easily with the ball of the right foot.	81.5	16.9	1.5
35.	Every applicant for a driver's license should be required to prove that he can drive safely.	81.5	12.3	6.2
36.	Shifting gears smoothly is one indication of sound driving and should be done by feel, eyes always on the road.	81.2	16.9	1.9
37.	Skillful driving demands adequate knowledge and proper use of the instruments, switches, and controls in the driver's compartment of the car.	80.8	18.4	.8
38.	One of the best safeguards against costly accidents is the foresight of common sense alertness.	80.4	16.9	2.7
39.	The driver's center of attention must be the place of potential danger on the road ahead.	80.0	17.7	2.3
40.	The driver must be aware that road surface affects starting, turning and stopping.	80.0	17.3	2.7
41.	A rear-view mirror should not be relied upon for a complete view of what is behind the car.	80.0	16.9	3.1
42.	Driving judgment is a composite characteristic including intelligence, experience, alertness, knowledge, attitudes, and self-control.	79.5	18.5	1.9
43.	The well-adjusted driver views the driving situation as a social activity involving the lives of everyone.	79.2	20.1	.8
44.	The speed limit determined by the state or city for any particular stretch of road should be considered the maximum safe speed under ideal conditions.	79.2	17.7	3.1
45.	To drive effectively and safely, one must see and be seen in time; stop and start in time; and signal and turn in time.	79.2	16.6	4.2
46.	A safe driver knows his deficiencies and compensates for them.	79.2	16.5	4.3

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as Essential	Desirable	Unnecessary
47.	After passing a vehicle, the driver should return to his own lane when he can see the vehicle in his rear-view mirror.	78.8	17.0	4.2
48.	In preparing to park, courteous and skillful drivers always signal their intentions, slow down, and get into the proper traffic lane.	78.7	20.9	.4
49.	In order to improve the present traffic accident record of teen-agers and young adults, the beginning driver must realize his personal and social responsibility for his own life and property and that of others.	78.1	21.1	.8
50.	The traffic officer on the spot has precedence in controlling traffic over the other traffic regulations and laws.	78.1	16.9	5.0
51.	As the speed of travel is increased, the probability of a death occurring in the event of an accident rises rapidly.	78.0	18.5	3.5
52.	One should never pull out in front of approaching traffic unless there is time to get up to cruising speed before another car overtakes one.	77.9	20.5	1.6
53.	Safe driving speed and sight distances are affected by curves, turns, hills, and intersections.	77.7	20.8	1.5
54.	When one is driving, the hand, the eye, and the foot must function in a co-ordinated manner.	77.6	18.1	4.3
55.	When driving in a fog at night, better visibility is obtained by using the lower headlight beam.	77.3	20.8	1.9
56.	The immature driver may resent the authority of the traffic officer and try to outwit him, but the mature driver co-operates with him.	77.3	19.2	3.5
57.	Under all driver-license acts, provision is made not only for issuing a license but also for suspending or revoking it.	77.2	20.5	2.3
58.	A significant solution to the traffic problem lies essentially in an intelligent, courteous, sportsmanlike pattern of driving behavior.	77.2	18.5	4.3
59.	The driver should slow down before entering a curve and as the car comes out of the curve gradually accelerate as the sharpness of the curve permits.	76.9	20.0	3.1
60.	With today's increased traffic volume and higher operating speeds, the passing maneuver requires a greater measure of caution and more clear space ahead.	76.4	21.2	2.3
61.	An accepted formula used by expert drivers is to allow a following distance of one car length for every 10 miles per hour of speed.	76.4	20.8	2.7
62.	There are so many adjustments the driver must make that unless he forms the right habits from the start, trouble looms ahead.	76.2	19.2	4.6
63.	When the right wheels slip off the edge of the pavement, the driver should slow down gradually until he can steer back onto the pavement at a convenient place.	75.4	24.2	.4
64.	The good driver develops the mental habit in which he automatically sees and thinks ahead.	75.3	23.2	1.5
65.	One of the most annoying and confusing problems in traffic is the rather common disregard for traffic signs and signals by many drivers and pedestrians.	75.0	21.2	3.8
66.	A driver's license is a privilege granted by the state.	75.0	18.1	6.9
67.	Perceiving situations accurately and fully is a prerequisite to safe driving behavior.	73.8	23.6	2.7
68.	The driving controls—steering wheel, clutch pedal, brake pedal, hand brake, gearshift lever or drive selector—are used to put the car in motion and direct it.	73.8	17.7	8.5
69.	Most accidents occur when the individuals involved least expect them.	73.7	20.5	5.8

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
70.	An automobile should be thoroughly checked by a competent mechanic at least twice a year to insure maximum operating efficiency and safety.	73.5	23.5	3.0
71.	The mature driver has complete control over himself, his driving techniques, and the changing driving conditions.	73.5	21.5	5.0
72.	Although the automobile has added greatly to the pleasures of life, it has also brought annoyances, inconveniences, and added hazards to life, limb, and property.	73.5	20.4	6.1
73.	Providing high school driver education for young drivers is one of society's important present-day problems.	73.1	21.1	5.8
74.	There are many unwritten laws, such as standard practice, common courtesy, and sportsmanship which should affect one's driving.	73.0	23.5	3.5
75.	Faulty attitudes of drivers are major factors in the causation of traffic accidents.	72.7	25.4	1.9
76.	Some traffic offenses are generally recognized as being so dangerous that in many states persons found guilty of the offense automatically lose their license for a definite period.	72.3	22.7	5.0
77.	Before one is near enough to read most traffic signs, one can still tell the general meaning by shape.	71.9	24.2	3.9
78.	Drivers should become aware of the common errors of pedestrians and bicyclists if accidents involving them are to be reduced.	71.5	25.0	3.5
79.	Sudden and unexpected actions of drivers are responsible for a large proportion of accidents.	71.4	24.3	4.3
80.5	Placing increased automotive power in the hands of man imposes upon him greater responsibility for traffic safety.	71.2	25.8	3.1
80.5	Fair play and adherence to the rules of traffic safety lead to smooth teamwork among drivers.	71.2	25.8	3.1
82.	Speed is very deceptive on a modern expressway, sometimes causing high-speed hypnosis which occurs when the road is straight, flat, and seemingly endless.	71.2	23.8	5.0
83.	Stopping distances are determined by known factors.	71.0	25.1	3.9
84.	Although one drives a great deal he is still a pedestrian most of the time and should consider safety practices from the pedestrian's viewpoint as well as the driver's.	70.8	28.4	.8
85.	If an accident is caused by negligence, the negligent person is held legally responsible.	70.8	24.6	4.6
86.	A car should be so driven and controlled as to enable the driver to avoid the mistakes of other drivers, pedestrians, or cyclists.	70.3	24.7	5.0
87.	The prolonged application of brakes is a dangerous driving practice in that the application of brakes produces heat which decreases brake efficiency.	70.0	27.7	2.3
88.	A safe driver keeps physically, mentally, and emotionally fit.	69.9	27.4	2.7
89.	The pedestrian and the driver must accept joint responsibility and must practice mutual co-operation before the problem of pedestrian accidents can be solved satisfactorily.	69.6	26.5	3.9
90.	The mature driver knows and recognizes changing driving conditions and adjusts to them long before an emergency arises.	69.5	27.4	3.1
91.	Bad weather lengthens a driver's danger zone at the time when a shorter zone is needed.	69.1	25.5	5.4
92.	Driving at night has proved to ge much more dangerous than driving during the daylight hours.	68.8	26.2	5.0
93.	Practically every traffic collision involves at least one violation.	68.7	25.1	6.2

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
94.	Any strong emotional disturbance tends to affect adversely the ability to think straight and to act wisely.	68.5	25.4	6.1
95.	The basic standard drivers' examination provides for testing applicants on motor vehicle laws, road signs, vision, and ability to drive.	68.3	27.4	4.2
96.	Good vision is an invaluable aid in helping to judge quickly in a driving situation.	68.2	26.4	5.4
97.	Where there are curves, hills, intersections, and variations in the number of lanes, varying degrees of danger exist.	67.3	27.3	5.4
98.	When a new car is purchased, it is important to obtain the proper certificates, guarantees and the dealer's invoice.	67.3	25.4	7.3
99.	Clear vision, driver comfort, and convenient location of controls are important to driving safety.	66.9	28.1	5.0
100.	Driving in accordance with changing road, traffic, and weather conditions, changing personal conditions; and changing conditions of the vehicle are marks of an efficient driver.	66.5	28.9	4.6
101.	The pedestrian should be regarded by the driver not as something that must be contended with, but as an individual who has some justification for the manner in which he conducts himself along the highway.	66.5	27.7	5.8
102.	When it is necessary to drive through water or in mud or sand or snow, the car should be kept in motion, if possible.	66.4	30.8	2.7
103.	In city driving one should keep in one lane of traffic as much as possible.	66.3	27.5	6.2
104.	The laws of motion and energy have established speed limits above which even the best driver cannot operate with safety.	66.2	27.3	6.5
105.	Repeated violations of traffic rules are indications of an impending accident.	66.0	28.6	5.4
106.	Anyone who drives should have his eyes examined at regular intervals.	65.8	30.8	3.4
107.	In order to acquire safe driving habits the driver must cultivate the desire to be safe.	65.8	27.3	6.9
108.	The driver who resents authority and restrictions upon his behavior tends to view traffic regulations as unnecessary.	65.8	26.2	8.1
109.	While records show that in over two-thirds of the vehicle-bicycle collisions, the bicyclist is at fault, still it is the responsibility of the automobile driver to be the more alert as his is the instrument of destruction.	65.5	29.1	5.4
110.	Proper driving practices aid in conserving gasoline, oil, tires, engine, and other vital parts of the motor vehicle.	65.4	30.0	4.6
111.	A safe driver constantly seeks to improve his driving.	65.4	28.8	5.8
112.	If the car is stuck in mud, snow, or sand, the car should be rocked by using first and reverse gears alternately.	65.2	31.3	3.5
113.	Right-of-way rules establish traffic priority under ordinary conditions.	65.2	28.6	6.2
114.	The inefficiencies in motor vehicle use are reflected by the number and severity of accidents and by traffic delays and congestion.	64.9	25.9	9.2
115.	The person who had the "last clear chance" to avoid an accident may be held responsible.	64.6	27.3	8.1
116.	Motor vehicles should receive preventive maintenance according to a pre-arranged schedule, to forestall the development of any condition or defect that would contribute to an accident or cause a breakdown on the road.	64.3	30.6	5.1

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
117.	Among the basic factors influencing a driver's susceptibility to a motor accident are exposure, speed, skill, and safety-mindedness.	64.1	31.3	4.6
118.	In driving through intersections, the lowest speed should be at the nearest crosswalk.	63.9	29.2	6.9
119.	No driver can consider himself competent unless he is prepared to meet successfully the common driving emergencies.	62.9	28.2	8.9
120.	The competent driver understands the effect of natural laws on motor vehicle operation in reference to specific driving situations.	62.5	33.2	4.2
121.	The most carefully planned and executed traffice engineering improvement can prove to be a complete failure if the driver behavior does not measure up to expectations.	62.5	31.3	6.2
122.	The good driver uses his brakes, his accelerator and steering wheel in such a manner that changes in speed and direction are started early and finished on time.	62.3	30.0	7.7
123.	A measure of good driving is the manner in which the open-road techniques of following, passing, meeting, stopping along a highway, and signaling intentions are observed.	61.0	35.1	3.9
124.	An emergency situation exists immediately before each and every accident.	60.9	27.1	12.0
125.	Knowledge of what makes the car go and the function of each of the main parts helps a driver attain competency.	60.8	36.5	2.7
126.	Traffic control devices consisting of signs, signals, and pavement markings provide drivers with information, directions, routes and destinations, and regulate the flow of traffic.	60.8	31.5	7.7
127.	The typical accident is the result of not one but a number of related factors.	60.2	34.0	5.8
128.	High death and accident rates are due for the most part to the misuse of the automobile and result in tremendous economic loss.	60.0	32.3	7.7
129.	Drivers should be acquainted with the physical, mental and emotional characteristics that are related to movement in traffic and the relationship between these characteristics and traffic accidents.	59.9	33.6	6.6
130.	Many pedestrians contribute to their own destruction because they have not formed proper habits of "where," "when" and "how" to walk.	59.6	33.5	6.9
131.	When starting on a slippery surface one should use second or high gear.	59.2	33.5	7.3
132.	A driver's general health affects his driving.	58.5	37.3	4.2
133.	Smooth, safe driving skill requires well-practiced techniques.	58.5	36.1	5.4
134.	As complete control of a car depends on the amount of friction between the tires and the road, increased speed and rough roads which decrease the amount of friction are hazards to safe driving.	58.1	37.3	4.6
135.	A person is considered negligent in the eyes of the law if he fails to act as a reasonable and prudent person would act in a particular situation.	58.1	35.0	6.9
136.	A driver usually can protect himself and other highway users by developing according to driving situations the proper compensating driving habits.	55.6	38.2	6.2
137.	An engine is a highly complicated device and should have careful treatment to insure proper operation.	55.4	40.4	4.2
138.	The wise driver plans regular inspections of his car by a competent mechanic who can foresee and prevent many costly motor jobs.	55.2	41.3	3.5

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as Essential	Desirable	Unnecessary
139.	A pedestrian should consider himself invisible to drivers and walk accordingly.	55.2	30.1	14.7
140.	Traffic safety, or the lack of it, is a product of the road, the motor vehicle, and the driver or pedestrian.	54.8	37.5	7.7
141.	Expert city driving involves the proper application of skills, knowledge and attitudes under trying circumstances of distraction and confusion.	54.8	34.4	10.8
142.	Traffic problems can be solved by the active interest and cooperative efforts of each citizen.	54.6	40.0	5.4
143.	The precision and speed with which a driver can direct his vehicle through a difficult maneuver is important to safety.	54.4	36.3	9.3
144.	The laws of nature, always operative when one is driving, take on special significance under adverse conditions.	54.3	34.9	10.8
145.	The expert driver controls his car so skillfully and cooperates with other road users so well that he blends into the normal flow of traffic.	54.2	38.1	7.7
146.	Tires should be rotated and wheels aligned at recommended intervals to assist in uniform wear and safety.	52.9	42.5	4.6
147.	Consistency in recommended behavior is an essential quality of a superior driver.	52.7	40.8	6.5
148.	Traffic laws have grown out of social needs, and are designed to be protective and to promote a smooth, efficient flow of highway traffic.	52.5	39.4	8.1
149.	Both adult and young people become upset and suffer unhappy feelings that may affect their performance in driving.	51.4	35.9	12.7
150.	Traffic lights are of great value in helping control the flow of traffic, but are only mechanical devices, unable to think for the driver.	51.2	34.2	14.6
151.	Financial responsibility laws require any owner or driver of a motor vehicle that is involved in an accident to furnish evidence of ability to pay for the damages caused.	50.8	37.3	11.9
152.	Enforcement deals with putting into practice the codes of custom, ordinance, or law.	50.6	40.9	8.5
153.	Control of the situation characteristically marks the psychologically mature driver.	50.6	37.1	12.4
154.	The ever-increasing use of motor vehicles has created a demand for improved streets and highways adequate for the density of traffic and for lessening of traffic hazards.	50.0	40.0	10.0
155.	In ascending a steep hill, the traffic sight distance ends at the hill crest.	49.2	37.7	13.1
156.	A bicyclist should learn to handle his cycle expertly before riding in traffic.	49.2	30.0	20.8
157.	People vary in their ability to see clearly against a strong light and the rapidity with which their eyes return to normal once the glare has subsided.	48.8	43.4	7.8
158.	Accident proneness increases when skill is lost through lack of practice.	48.8	40.0	11.2
159.	For greater safety and convenience in traffic movement, sound scientific principles need to be applied in automobile improvements, highway construction and traffic engineering.	48.1	41.1	10.8
160.	Good driving on city streets is measured in terms of sharing space, time, and traffic facilities.	47.9	41.7	10.4
161.	Motor vehicles have reduced the isolation of rural areas, extended the services of fire and police protection, and made possible increased medical and hospital care.	47.7	40.0	12.3

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
162.	The fact that accident involvement increases despite a reduction in mileage traveled during poor weather makes it obvious that man has not yet learned to compensate for hazards due to weather conditions.	47.5	42.9	9.6
163.	The traffic accident problem created a need for a sound traffic program of engineering, legislation, enforcement and education.	47.3	35.7	17.0
164.	Tire chains are useful to increase traction on snow or ice.	46.9	41.5	11.5
165.	Longer tire wear and greater safety may be obtained by checking the tires weekly for proper inflation and general condition.	45.8	49.2	5.0
166.	When driving in a progressive signal system, the correct speed is that for which the lights are set.	45.8	43.1	11.1
167.	Gains in time on a trip by increasing speed are far less than might be expected.	45.1	45.6	9.2
168.	As the volume of traffic increases, the indications are that a driver's license will become harder to get, and harder to keep.	45.0	42.3	12.7
169.	One should buy a used car from an honest, reputable dealer who is as interested in future goodwill as in a possible present sale.	44.6	38.1	17.3
170.	It is the amount of alcohol that gets into the blood stream, not how much liquor is drunk, that determines the degree of intoxication.	44.2	37.3	18.5
171.	Statistically the odds are against the careless pedestrian being able to out-maneuver the automobile driver.	43.5	41.5	15.0
172.	Traffic accidents are an example of man's failure in his social responsibilities.	41.5	40.4	18.1
173.	Too many motorists fail to perform even a minimum of maintenance on their cars.	40.8	42.7	16.5
174.	The automobile is an expensive, complex, carefully machined instrument that can be abused in starting.	40.5	44.0	15.4
175.	The accident experience in a community is a measure of the effectiveness of the total traffic program because accidents are material indications of something wrong.	40.2	44.0	15.8
176.	The maintenance recommendations of the car manufacturer should be followed in general.	39.9	46.1	14.0
177.	Pertinent individual characteristics, such as visual abilities, and even the disposition to employ them, vary from one driver to another and from one time to another for each driver.	38.5	47.7	13.8
178.	A daily inspection of the tires, lights, horn and windshield cleanliness should be made prior to operation of the motor car.	38.1	50.8	11.1
179.	Failure of cyclists to accept the responsibility for conforming to the rules and regulations designed largely for the bicyclist's safety has been responsible for many motor vehicle-bicycle collisions during recent years.	37.8	46.0	16.2
180.	Traffic engineering attempts to make it difficult for the driver to become involved in an accident.	36.5	43.9	19.6
181.	Highway transportation has had a tremendous impact on our society through the general improvement of public welfare.	36.3	41.7	22.0
182.	An understanding of the precision workmanship and complex mechanism in the manufacture of a car creates an appreciation for the proper use and maintenance of an automobile.	35.4	46.1	18.5
183.	Uniform bicycling regulations will benefit both bicyclists and motorists by reducing traffic delay, confusion, and accidents.	35.4	44.2	20.4

TABLE 6. (*Continued*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
184.	Accurate and comprehensive traffic facts, properly evaluated, are the first requisites to sound traffic engineering decisions.	34.2	41.5	24.2
185.	States vary on the age for licensing drivers, although 16 is the age most commonly specified in state laws.	33.6	41.3	25.1
186.	Motor vehicle accidents tend to cluster in certain locations.	33.0	44.0	23.0
187.	The automobile has changed social customs, family activities and domestic points of view.	32.7	40.8	26.5
188.	Not only has the automobile age created new occupations and industries, but also it has decentralized the industries to make possible living in suburban areas.	31.9	41.5	26.5
189.	Synchronized traffic lights are important to traffic control in large cities.	31.7	44.4	23.9
190.	A safe, happy motoring trip requires good planning in advance.	31.5	45.4	23.1
191.	The motor vehicle has improved the business relationship of the American people by extending the market area both for produce of the farm and the products of the manufacturer.	30.4	43.1	26.5
192.	There is a great temptation when purchasing a used car to judge the car on sight.	30.0	48.1	21.9
193.	Uniformity in traffic control devices throughout the country is desirable and essential for maximum effectiveness.	29.7	50.2	20.1
194.	Broader educational opportunities through centralized or consolidated schools have been stimulated by the introduction of motor vehicles.	29.6	43.1	27.3
195.	Intelligent use of enforcement personnel is characterized by a deployment of manpower which is proportionate to the need for supervision in any given part of a city.	29.2	44.2	26.5
196.	The basis of automotive power is in the production and control of explosions.	28.9	42.9	28.2
197.	The use of the automobile has encouraged intersectional travel and people of the United States have been brought closer together.	28.8	42.7	28.5
198.	Congested streets and highways in many cities result in delay and slowing down of business travel, thus negating many of the advantages of the automobile.	28.2	44.0	27.8
199.	Complexity of increasing traffic requires the assistance of traffic engineers.	28.0	48.5	23.5
200.	Getting smooth, economical action from an automatic transmission car requires sound practice.	27.7	53.1	19.2
201.	Sound traffic engineering is based on study, facts, and a grasp of changing needs.	27.3	46.2	26.5
202.	The automobile is made up of units held firmly together and designed to work in harmony.	26.1	46.1	27.7
203.	The coming of the automobile has changed our recreational pursuits by making available a greater choice of activities.	25.8	42.3	31.9
204.	The three-lane highway is regarded by most traffic specialists as an unsafe design.	25.0	53.8	21.1
205.	Diverse local traffic ordinances are confusing and inadequate for today's widespread motor vehicle travel.	22.3	49.2	28.5
206.	Modern road construction emphasizes increased sight distances which are achieved by elimination as far as possible of dips, curves, and blind corners.	22.0	53.3	24.7
207.	Transmissions of the type generally known as automatic are intended to relieve the driver of part of the labor of operating the clutch and gearshift lever while operating the car.	21.9	50.0	28.1

TABLE 6. (*Concluded*)

Rank Order	Concept	Per Cent Rating Concept as		
		Essential	Desirable	Unnecessary
208.	The trend today in road construction in some areas is toward the development of a network of super-highways specially designed to handle high speed traffic with safety.	18.8	48.1	33.1
209.	In general, the higher the initial price of a car, the more it costs to own, operate, repair, and replace it.	16.1	43.5	40.4
210.	Heavily used roads are usually paved with a hard, smooth layer which will bear heavy loads, keep out water, and wear well.	11.1	37.7	51.1

[1] Because of space limitations, only Table 6 of the study is reported here.

3. An evaluation of the emphasis given to the various topical areas of driver education.

4. A comparison of concept ratings made by males and females.

5. The organization of units of instruction around closely related concepts.

6. The development of a reliable and valid test of understandings of these concepts suitable for use at the secondary school level.

7. A determination of the relationship between an understanding of these concepts and other factors in the reduction of traffic accidents and violations.

Limitation of the Study

Although students participating in the evaluation phase of the study had completed a course in driver education, no attempt was made to determine whether the students were licensed drivers. A student's evaluation of the concepts might possibly be affected by whether the student had been or had not been granted a license.

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(Submitted 2/21/57)

Extension of the Kraus-Weber Test[1]

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Abstract

This study extended the Kraus-Weber Tests of Minimum Muscular Fitness in order to provide more differentiating scores at all levels of ability. A pass or fail score, which could be determined from the continuous scoring system, was also obtained. Results indicate that strength and flexibility differ with age and sex and that the standards, even though considered minimal, should also vary with the different ages and sex groups.

WIDE INTEREST in the muscular fitness of the American children was initiated by the Kraus-Weber Tests for Muscular Fitness (6). Although this test is reliable and easily administered, the empirically derived and non-differentiating type of scoring is not valid for use in physical education classes.

Three of the Kraus-Weber tests require that the test position be held for ten seconds. This standard applies to both boys and girls regardless of age as does the requirement of only one of the more difficult type of sit-ups in which the knees are bent. Kraus stated that standing with the feet together and the knees straight, the normal person should be able to touch his fingertips to the floor and then found that over half of the normal schoolchildren could do this. However, studies on normal flexibility according to age and sex groups by Kendall and Kendall (5) and others (3, 4) produced evidence that it is not normal for all age groups and that girls are more flexible than boys. The suggested battery does not include tests for the arms and legs, areas of the body which are certainly important in fitness for daily living. These tests leave much to be investigated as far as the interpretation and scoring of the tests are concerned if we are to make use of them for the purpose of selecting the school child who is physically weak rather than only those who are predisposed to backache.

Purpose

The purposes of this study were as follows:

1. To extend the Kraus-Weber tests, through the addition of time or trials, in order to provide a type of scoring which is differentiating at all levels of ability.

2. To include a score such as would have been obtained on the pass-fail basis used in the Kraus-Weber tests in order to compare the results of administering the Kraus-Weber tests to the same age groups in two successive years.

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[1] This study was conducted under the direction of Dr. M. Gladys Scott at the State University of Iowa, Iowa City, Iowa, 1956.

3. To add tests for areas of the body which were neglected in the Kraus-Weber tests.

Procedure

The author received preliminary instruction and supervision on the proper testing procedures for the Kraus-Weber tests from a member of the staff at the State University of Iowa who had been trained and certified by Dr. Hans Kraus in the administration of the tests. When help was received, it was from this instructor, but all of the testing in which judgment was a factor in the scoring was done by the author.

Motivation consisted of encouraging the children to do their best. Counts were made out loud and times were given as the children took the tests.

All of the tests except the back tests (Test 4 and Test 5) and the two easier abdominal tests (Test 2 and Test 3) were repeated within two days to test reliability. The back tests were limited to three minutes and the abdominal tests were not of much value other than their indication of the amount of help given those who could not pass the repeated sit-ups test. The reliabilities were computed on numbers which varied from 50 to 61 and included ages 6 through 15 years distributed throughout the total group tested during the four-month period.

TEST DESCRIPTIONS[2]

Test 1—Repeated Sit-ups. The more difficult abdominal position in the third Kraus-Weber test, that in which the subject lay supine with knees bent and feet held on the table, was used as the first test and repeated as many times as the subject could continue rather than only once as in the Kraus-Weber tests. The score was the number of sit-ups.

Test 2—Assisted Sit-ups. A child unable to do one sit-up on Test 1 was assisted and scored as provided by the Kraus-Weber Test.

Test 3—Straight Leg Sit-ups. From a supine position, legs straight and feet held down by the examiner, the subject was asked to sit up. If he passed, his score was ten points, but if he failed he was again given assistance and scored as in the Kraus-Weber tests. The child was not asked to do Test 3 if he passed the more difficult sit-up in Test 1. It was assumed that he could do the easier one if he succeeded with the more difficult sit-up.

Test 4—Upper Back Strength

Test 5—Lower Back Strength

Test 6—Psoas and Lower Abdominals

These three tests were administered as in the Kraus-Weber tests except that the limits were all extended to as long as the test position could be held. In the upper and lower back tests, however, the time had to be limited to three minutes for administrative purposes, but this time seemed to provide a sufficient variety of scores beyond the ten second limit. It was discovered

[2] A complete description of the scoring used in the Kraus-Weber tests can be found in the *Research Quarterly*, May 1954.

that many children could hold the position five minutes or longer which would have involved too long a testing time. It was apparent that the psoas test was much more difficult than the upper or lower back tests and no time limit was needed.

Test 7—Push-ups. The modified push-up test as described in Scott and French (8) was used to test arm and shoulder girdle strength. Beginning with the down movement, one count was given for each direction, up or down, completed.

Test 8—Leg Strength. A vertical jump with the arms folded was the measurement of leg strength. A paper scale was taped to the wall and a belt with a pointer was placed around the subject's waist. The readings were taken with the subject in standing position and at the height of the jump. The difference between the two readings was calculated, and the score was the number of inches jumped on the best of three trials.

Test 9—Flexibility (Trial 1). In order to obtain scores at the various levels of flexibility in touching the floor with the fingertips, knees straight, the subject was asked to stand in stockinged feet behind a rule on a stool which was six inches off the floor. His knees were held straight, and he was asked to see how close he could come to touching the floor with his finger tips. When the measurement was taken, he was asked to step down off the stool, spread his feet apart, bend over with his head close to his knees, and relax like a rag doll.

Test 10—Flexibility (Trial 2). After the second practice bend, the subject was asked to stand in stockinged feet behind a rule on a stool which time he was given the instruction to relax, get his head close to his knees, and to try to get farther down than the first time. In both tests the scores were in inches of success or failure in reaching the toes or beyond.

Subjects

The data were collected from 1,057 Iowa school children between the ages of 6 through 15 from six schools in the Iowa City area. Table 1 gives the number of children in each age and sex group tested.

TABLE 1
Numbers of Boys and Girls Tested at Each Age Level

Sex	Age										Total
	6	7	8	9	10	11	12	13	14	15	
Boys	50	50	53	62	50	56	47	50	50	50	518
Girls	50	53	67	68	52	50	50	50	50	49	539
Total	100	103	120	130	102	106	97	100	100	99	1057

Analysis and Discussion of Data

The reliabilities obtained are given in Table 2. It is probable that the reliabilities would have been more meaningful if computed for each age and

sex group, but this was an impossibility due to the numbers involved and the time needed for testing.

TABLE 2
Test Reliabilities

Test Number	Name of Test	Number Tested	Coefficients
1	Repeated Sit-ups	53	.94
6	Psoas and Lower Abdominals	50	.90
7	Push-ups	57	.83
8	Leg Strength	61	.93
9	Flexibility (Trial 1)	50	.95
10	Flexibility (Trial 2)	50	.96

In 1955, Atwood (1) administered the Kraus-Weber tests to children ages 6 through 12 in three of the same schools used in this study. Although no name-by-name matching of scores was made, it was apparent that the school population had changed very little over the year's time, and the Kraus-Weber tests were given to the children in these three schools in the same age groups. Table 3 gives a comparison of these results with those obtained on the American children tested by Kraus (6). The reliability of the Kraus-Weber tests is apparent in these results. The Iowa City children were again inferior to the Kraus group with the exception of the per cent of weakness failures.

TABLE 3
Comparison of Test Failures on Various Administrations of the Kraus-Weber Tests

Group	Deficiency[1] %	Incidence[2] %	Flexibility %	Weakness %
American (6)	57.9	80.0	44.3	35.7
Iowa City, 1955 (1)	66.1	88.6	56.9	34.8
Iowa City, 1956	65.7	83.8	57.5	26.2

[1] Per cent of deficiency refers to the per cent of children who failed one or more tests.
[2] Per cent of incidence refers to the number of tests failed in relation to the total number tested.

With a more differentiating type of scoring, however, a great deal more information is available concerning the muscular fitness levels of the Iowa children. Figure I indicates that not only are the boys stronger than the girls at all ages after six in the Push-ups and Repeated Sit-ups Tests, but that the mean scores for both tests also differ with age. The Kraus-Weber tests require only one of the more difficult type of sit-ups for both boys and girls at any age. However, the difference between the girls and boys mean scores and the differences in mean scores at the various age levels would indicate that it is not logical to apply one standard, even though it may be considered a minimal one, to any age of either sex.

Owing to the fact that so few children failed the back tests as scored in the Kraus-Weber tests, these items can scarcely be called discriminatory.

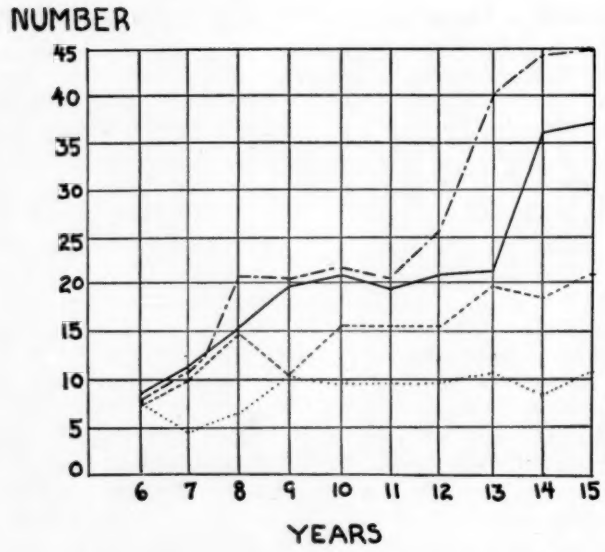

FIGURE I. Mean Performance of Successive Age Groups on Repeated Sit-Ups and Push-Ups

Sit-Ups	*Push-Ups*
——— boys	— - — - boys
- - - - girls	..... girls

Figure II reveals the fact that, even with the three-minute limit enforced, the average scores were considerably over the ten seconds as advocated by Kraus. The fact that the psoas test position is much more difficult to hold is also graphically illustrated. Therefore, more study is needed in order to determine the various minimum time limits applicable to these different tests for the various age levels.

On the psoas test, an increase in age in the groups tested was accompanied by a decrease in mean scores which was significant at the 1 per cent level of confidence for the girls (CR 4.4) and for the boys at the 5 per cent level of confidence (CR 2.2). The apparent decrease in strength in the older age groups tested may well be due to the increased length of the legs. The longer the legs the greater the need for strength, because of the longer level. Even increased strength of the psoas muscles might still yield a poor showing if the increase was not sufficient to meet the increased leverage requirements.

Figure III illustrates the successes and failures in reaching the toes or beyond and indicates the amount of improvement that results with a slight warm-up immediately prior to taking the test. The mean scores indicated that the girls were more flexible than the boys, and age 12 represented the age at which both boys and girls were the least flexible. For these reasons,

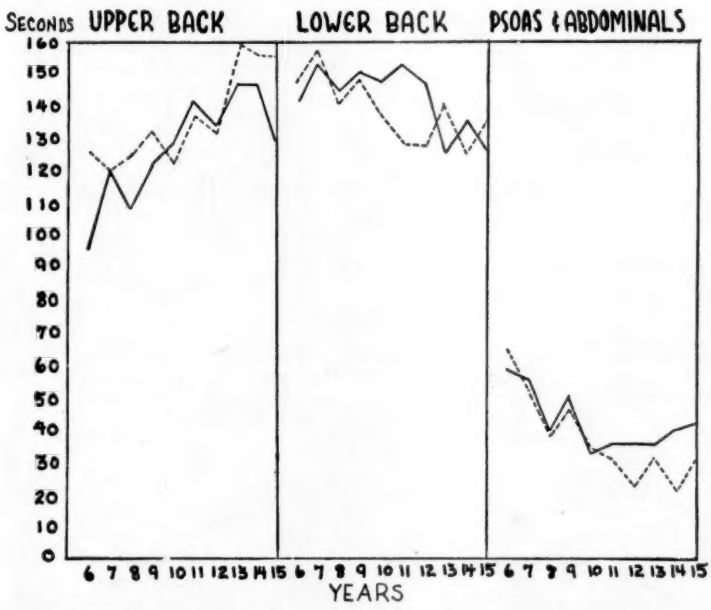

FIGURE II. Mean Performance of Successive Age Groups on Tests with Ten-Second Limits in the Kraus-Weber Tests

——— boys
- - - - girls

perhaps the rigid requirement of being able to touch the toes with the knees straight and only one trial allowed should not apply to both boys and girls at all ages.

Figure IV illustrates the fact that on the average the girls scores were poorer than the boys scores on the leg strength test. This was particularly true at the ages of 14 and 15 when the boys mean scores were significantly different from the girls mean scores. These differences were each significant at the 1 per cent level of confidence. Difference in means for girls at ages 6 to 15 were significant at better than the 1 per cent level of confidence (CR 21.4) as was also true of the boys scores (CR 13.1). Thus, there is no one standard that could apply even at a minimal level in the leg strength test to all ages of either sex.

Summary and Conclusions

The Kraus-Weber tests could provide the basis for a reliable, valid, easily administered muscular fitness test which involves little or no equipment after more attention has been given to the minimum requirements for the different age and sex groups. It is apparent from the results of this study that strength

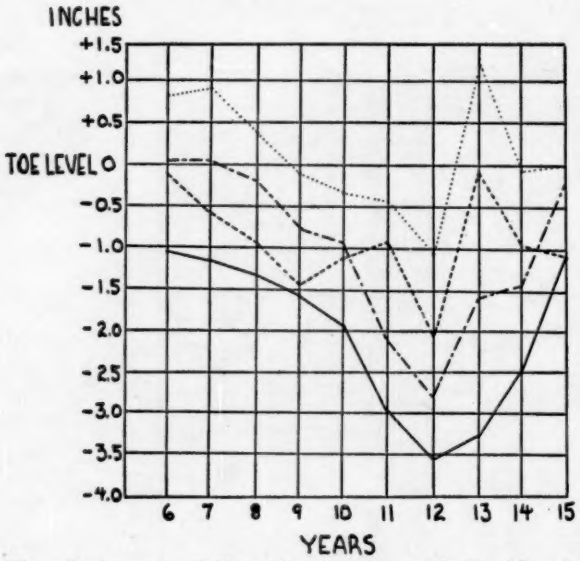

FIGURE III. Mean Performance of Successive Age Groups in Reaching the Toes or Beyond

Trial One
——— boys
– – – – girls

Trial Two
— – — – boys
..... girls

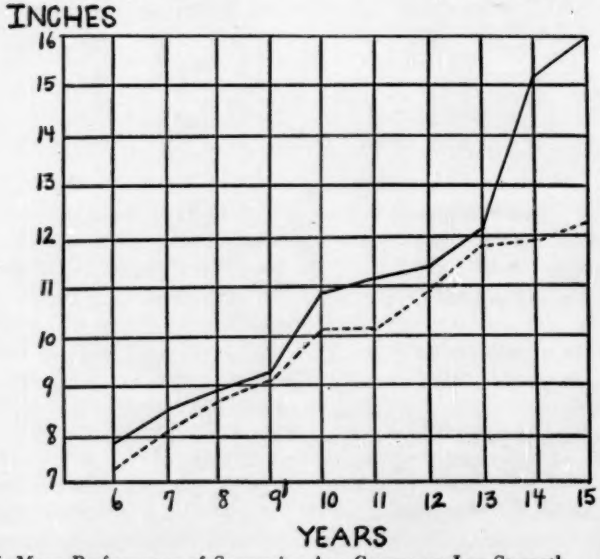

FIGURE IV. Mean Performance of Successive Age Groups on Leg Strength
——— boys
– – – – girls

and flexibility do differ with age and sex, and therefore the standards, even minimal ones, should also vary with the different ages and sex groups.

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(Submitted 3/7/57)

Linearity of Contributions of Ages, Heights, and Weights to Prediction of Track and Field Performances[1]

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Abstract

From the records in three track-and-field events (standing broad jump, softball throw, and six-second run), the ages, the heights, and the weights were obtained from 882 boys and 900 girls ranging in ages from 9 to 17 years. The relationship between ability in athletics (as measured by the records in the three track-and-field events) and the variables of age, height, and weight was, for the boys and for the girls, found to be nonlinear.

NUMEROUS STUDIES have been conducted on the relative influence of age, height, and weight on motor performance. In 1932 McCloy (3) proposed the formula of 20 Age (yr.) + 6 Height (in.) + Weight (lb.) as a classifying and handicapping device for boys. In 1934 Neilson and Cozens (5) presented the formula of Age (mo.) + .3 Height (in.) + .66 Weight (lb.) for classifying elementary school and junior high school boys and girls for physical education activities.[2]

The formula proposed independently by McCloy and Neilson-Cozens for predicting motor performance from weightings of age, height, and weight have assumed linearity of the correlations among these variables. However, in 1935, McCloy (2) studied the linearity of chronological age and performance ability and came to the conclusion that the relationship of age to performance is curvilinear.

The purpose of the present study was to determine whether the relationships between performance and age, performance and height, performance and weight, and performance and the combination of age, height, and weight were linear or nonlinear.

Procedure

The subjects, 882 boys and 900 girls, ranged in age from 9 to 17 years. They were selected from the physical education classes of the Amarillo, Texas, Public Schools.

The data obtained were records in three track and field events (standing broad jump, softball throw, and 6-second run), ages, heights, and weights.

[1]A condensation of a Ph.D. dissertation, State University of Iowa, 1955.

[2]The Neilson-Cozens formula translated into terms of the McCloy formula becomes 20 Age (yr.) + 5.5 Height (in.) + 1.1 Weight (lb.).

The standing broad jump was executed from a take-off board onto a tumbling mat. The best of each subject's three jumps, measured to the nearest inch, was taken as the score.

The softball throw (12-in. ball) was executed from within a circle 8 ft. 2.5 in. in diameter. The best of each subject's three throws, measured to the nearest foot, was taken as the score.

The procedures described by McCloy (4) were employed in scoring the 6-second run.

Age was taken from the school records to the nearest month.

Height was taken to the nearest half-inch.

Weight was taken in the nude or with very little clothing and recorded to the nearest pound.

Analysis of Data

The raw scores in each of the three events were converted into scores, using McCloy's Universal Scoring Tables (3) and tables computed by the McCloy method (4). The converted scores were summed, thus giving a total performance score for each subject.

The obtained performance scores were sorted into age groups, and intercorrelations among performance scores, heights, and weights were obtained at each age level (9 to 17). Regression equations for predicting performance scores from height and weight were then derived. From these equations, a performance score was predicted, according to the McCloy method (2), for the ages of 9 to 17 years. These performance scores were predicted for each age from the mean height and the mean weight of the age before and of the age following the age under consideration. The performance score that was adopted to represent the mean performance score for each age was the average difference of performance scores as computed by the equation from the age before and from the age following. For example, the difference between the 12-year-old actual mean performance score and the mean performance score obtained by using the mean height, and the mean weight of the 12-year-old in the 11-year-old equation, was averaged with the difference between the 11-year-old actual mean performance score and the mean performance score obtained by using the 11-year-old mean height, and the mean weight in the 12-year-old equation.

The same procedures as those used in predicting the performance scores for the ages of 9 to 17 years were used in predicting the mean performance scores for the heights at two-inch intervals, from 52 to 71 inches, and for the weights at ten-pound intervals, from 50 to 179 pounds.

SMOOTHED SCORES

The derived scores were, by the use of simultaneous equations, smoothed algebraically by the method of least squares (6).

According to Age, for Boys (Table 1). Yearly increments in the mean performance scores increased from the age of 9.5 years to that of 15.5

TABLE 1
Increase (or Decrease), According to Age, in Mean Performance Scores in Track and Field Athletics

Age (yr.)	Boys (N=882)		Girls (N=900)	
	Derived Score	Smoothed Score	Derived Score	Smoothed Score
9.5	33	33	19	18
10.5	47	43	23	27
11.5	60	52	50	36
12.5	41	60	40	41
13.5	51	65	11	43
14.5	83	69	71	39
15.5	114	70	0.6	28
16.5	17	69	38	9
17.5	80	65	−32	−19

years, after which the increments decreased in magnitude. Hence age made its greatest contribution to the prediction of ability in athletics at 15.5 years.

According to Age, for Girls (Table 1). Yearly increments in the mean performance scores increased from the age of 9.5 years to that of 13.5 years, after which the increments decreased in magnitude. Hence age made its greatest contribution to the prediction of ability in athletics at 13.5 years.

According to Height, for Boys (Table 2). Increments in the mean performance scores increased from the height of 51 inches to that of 71 inches. Hence, height made its greatest contribution to the prediction of ability in athletics at 71 inches.

According to Height, for Girls (Table 2). Increments in the mean performance scores decreased from the height of 51 inches to that of 69 inches. Hence, height made its greatest contribution to the prediction of ability in athletics at 51 inches. This finding is contradictory to the results obtained from the data for the boys.

TABLE 2
Increase (or Decrease), According to Height, in Mean Performance Scores in Track and Field Athletics

Height (in.)	Boys (N=818)		Girls (N=893)	
	Derived Score	Smoothed Score	Derived Score	Smoothed Score
51			44	44
53	4	4	35	42
55	34	8	53	40
57	−25	11	17	38
59	−4	15	45	35
61	46	19	59	31
63	34	26	14	25
65	3	34	29	19
67	105	43	−43	11
69	8	53	34	2
71	73	65		

TABLE 3
Increase (or Decrease), According to Weight, in Mean Performance Scores in Track and Field Athletics

Weight (lb.)	Boys (N=874)		Girls (N=873)	
	Derived Score	Smoothed Score	Derived Score	Smoothed Score
55	14	14	51	54
65	25	13	33	33
75	46	12	−24	12
85	−18	9	23	− 6
95	−42	4	−27	−20
105	2	−0.8	−5	−28
115	−57	− 6	−39	−34
125	56	−11	4	−29
135	−10	−14	−41	−20
145	26	−16	−17	− 4
155	−37	−16		
165	−25	−12		
175	−10	− 6		

According to Weight, for Boys (Table 3). Increments in the mean performance scores decreased from the weight of 55 pounds to that of 95 pounds, after which the increments were negative. Hence, weight made its greatest contribution to the prediction of ability in athletics at 55 pounds.

According to Weight, for Girls (Table 3). Increments in the mean performance scores decreased from the weight of 55 pounds to that of 75 pounds, after which the increments were negative. Hence, weight made its greatest contribution to the prediction of ability in athletics at the weight of 55 pounds. This pattern was similar to that in the data for the boys.

CORRELATION-RATIOS

Classification scores were computed from the sums of the smoothed predicted performance scores. Eta's were obtained between the original performance scores (computed for each subject from the raw data), and the classification scores were read from the tables which were computed from the smoothed predicted performance scores. These η's were .882, for the boys, and .615 for the girls.

Coefficients of correlation were then obtained between the original performance scores (computed for each subject from the raw data) and the classification scores. The r's were .861 for the boys, and .519 for the girls. Blakeman's Test of Linearity (1) was then applied to determine whether the data were linear or nonlinear. The formula used was the following: $N(\eta^2 - r^2) < 11.37$. The test indicated that the data for the boys (16.85 and 32.28) and for the girls (13.23 and 97.92) were nonlinear.

Summary and Findings

The data used in this study were records in three track-and-field events (standing broad jump, softball throw, and six-second run), ages, heights,

and weights. The subjects, 882 boys and 900 girls, ranged in age from 9 to 17 years. They were selected from the physical education classes of the Amarillo, Texas, Public Schools..

The findings obtained from the analysis of the data follow:

1. Age made its greatest contribution to the performance scores of the boys at 15.5 years; and of the girls at 13.5 years.
2. Height made its greatest contribution to the performance scores of the boys at 71 inches; and of the girls at 51 inches.
3. Weight made its greatest contribution to the performance scores of the boys and of the girls at 55 pounds.
4. The relationship between ability in athletics and age, height, and weight is, for the boys and for the girls, nonlinear.
5. The relationship between performance ability in standing broad jump, softball throw, 6-second run, age, height, and weight is, for the boys and for the girls, ages 9 to 17, nonlinear.

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(Submitted 11/7/55)

Relationships of Strength and Anthropometric Measures to Physical Performances Involving the Trunk and Legs[1]

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Abstract

In this study, 16 strength and 10 anthropometric tests were related by correlational methods to 8 trunk and leg measures, involving dynamometric strength, muscular endurance, agility, and power. The intercorrelations among some of the anthropometric variables were especially high: .91, standing height with leg length; .88, foot length with leg length; and .87, body weight with both hip width and thigh girth. The highest strength test intercorrelation was .65 between trunk flexion and extension. Significant multiple correlations obtained were: .74 for leg lift with body weight, ankle dorsal flexion strength, and trunk flexion strength; .71 for back lift with knee extension strength, hip width, trunk flexion strength, and knee flexion strength; and .66 for standing broad jump with adipose tissue over the abdomen (negative) and hip extension strength (positive).

RELATIONSHIPS of strength and anthropometric measures to various arm strength criteria for mesomorphic and meso-ectomorphic college men have been reported by Clarke (3). Correlations of .73 and .74 were obtained between girth of the flexed-tensed upper arm and McCloy's arm strength formula scored with push-ups, pull-ups, and combined push-ups and pull-ups. A multiple correlation of .80 resulted between these arm strength scores and the following experimental variables: girth of the flexed-tensed upper arm, standing height, and strength of the shoulder inward rotator muscles. The multiple correlation with push-ups in the formula reached .87, when elbow flexion and shoulder flexion endurance measures were included.

In an unpublished study (4), cable-tension strength tests of hip and knee muscles were related to back and leg strengths by dynamometer measures. The multiple correlation with leg strength was .64; strengths of the hip adductor, hip extensor, and hip flexor muscles were the independent variables.

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For the back lift, the multiple correlation was low (.27)—an understandable result since no cable-strength tests of the trunk muscles were available at the time of the study.

The purpose of this research was to investigate further the relationships of strength and anthropometric measures to physical performances primarily involving the trunk and legs. The experimental variables were sixteen strength and ten anthropometric tests. Eight trunk and leg measures, involving dynamometric strength, muscular endurance, agility, and power, composed the criteria. The subjects were 53 unselected, nondisabled male students at the University of Oregon.

Experimental Variables

STRENGTH TESTS

The 16 strength tests utilized in the study were for the following muscle groups: trunk extensors, flexors, lateral flexors, and rotators; hip flexors, extensors, abductors, adductors, inward rotators, and outward rotators; knee flexors and extensors; and ankle plantar flexors, dorsal flexors, inverters, and everters. Strength was measured with a cable tensiometer applied to a specially designed pulling assembly, in accordance with techniques developed by Clarke (1). The testing was unilateral, left side only, with the exception of course, of the trunk extensors and flexors.

ANTHROPOMETRIC TESTS

The ten anthropometric tests included were as follows: standing height, sitting height, leg length, body weight, thigh girth, calf girth, foot length, hip breadth, adipose tissue over the abdomen, and adipose tissue over the ilium. The girth measurements were made with a cloth tape attached to a Gulick handle. The spring in this handle permitted the application of consistent tension, which was of special value in making objective measurements over soft tissue (6). Wooden sliding and spring-tension calipers were used in testing for hip width and foot length and for adipose tissue measurements respectively. Those testing techniques requiring explanation are as follows:

Leg length: This measurement was the difference between standing and sitting heights.

Thigh girth: The subject stood in a normal standing position with the weight evenly distributed on both feet; the measurement was made at the point of greatest girth of the left thigh.

Calf girth: The subject stood as for the thigh girth test; and the measurement was made at the point of greatest girth of the left calf.

Foot length: The subject stood in erect position, feet parallel and about six inches apart with weight distributed evenly through both lower limbs; the left foot length was measured with sliding calipers from the heel to the distal point of the longest toe.

Hip breadth: The subject was in a normal standing position with weight distributed evenly on both feet; sliding calipers were applied to the sides of the iliac crests with enough pressure to feel bone resistance.

Adipose tissue over the abdomen: The subject stood in a normal position; the pinch calipers were applied horizontally at a point approximately two centimeters above and to the left of the umbillicus.

Adipose tissue over the ilium: The subject was in a normal standing position; the measurement was taken at a position two centimeters superior to the crest of the left ilium in a line vertical with the left axilla.

Trunk and Leg Criteria

The following eight performances involving the trunk and legs were used individually as criteria: back lift, leg lift, vertical jump, standing broad jump, squat jumps, squat thrusts for 12 seconds, squat thrusts for one minute, and sit-ups for two minutes. Brief descriptions of these tests follow:

Back lift: The back lift was administered with a dynamometer; in lifting, the knees were kept straight and the back was bent slightly (2, *p. 160*).

Leg lift: A dynamometer was also used in giving the leg lift, with a belt holding the lifting bar firmly in place at the hips; in lifting, the back of the subject was erect and the knees were slightly bent at the point of maximum effort (2, *p. 161*).

Vertical jump: The "chalk-mark" method was used; the distance was the number of centimeters between the point the subject could reach from a flat-footed position and the height to which he could jump from a crouch position; the best of three trials was recorded (2, *p. 273*).

Standing broad jump: The take-off for the standing broad jump was from both feet on a mat, without a take-off board; performance was measured to the nearest inch; the best of three trials was recorded.

Squat jumps: With the fingers locked and placed on top of the head, the subject jumped upward from a squat position as many times as he could continuously; the feet cleared the floor with each jump (2, *p. 195*).

Squat thrusts: Starting from a standing position, the subject performed squat thrusts as many times as he could in a specified length of time: 12 seconds for one test and one minute for a second test (2, *p. 194*).

Sit-ups: From a supine position with hands clasped behind the head and with feet held down by the scorer, the subject did as many sit-ups as he could in two minutes (2, *p. 194*).

Results

All experimental variables were intercorrelated and were correlated with each of the trunk and leg criteria by means of the Pearson product-moment method. In interpreting the correlations, *r*'s of .27 and .35 are significant at the .05 and .01 levels of confidence respectively for 51 degrees of freedom. A coefficient of multiple correlation was computed to select the experimental variables which best represented or accounted for each criterion by the Wherry-Doolittle method. The multiple correlations significant at the .05 and .01 levels respectively were as follows: for three variables, .34 and

.41; for four variables, .39 and .47; and for five variables, .42 and .49. (5, *p. 437*).

INTERCORRELATIONS

The intercorrelations among the 26 experimental variables and the correlations with the eight trunk and leg criteria appear in Table 1. Appropriate interpretations of these 533 correlations follow.

TABLE 1 (Part 1)

Intercorrelations of Strength and Anthropometric Measures and Their Correlations with Selected Trunk and Leg Strength Criteria for College Men

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.		.65	.58	.00	.10	.37	.07	.14	.46	.27	.40	.30	.48	.19	.26	.34	.64	.27
2.			.34	−.12	.15	.41	−.06	−.11	.38	.26	.34	.24	.23	−.06	.28	.30	.42	.19
3.				.29	.37	.39	.41	.14	.36	.34	.06	.30	.44	.36	.34	.25	.58	.31
4.					.45	.16	.53	.36	.33	.21	.05	.17	.42	.46	.18	.25	.23	−.02
5.						.57	.48	.36	.40	.12	.26	.51	.32	.45	.40	.24	.29	.18
6.							.26	.25	.40	.22	.45	.45	.44	.37	.51	.34	.50	.26
7.								.44	.29	.36	.11	.22	.29	.50	.43	.17	.17	.08
8.									.19	.18	.22	.39	.37	.52	.26	.39	.21	.29
9.										.40	.17	.44	.56	.43	.45	.58	.42	.25
10.											.18	.31	.17	.36	.38	.26	.22	.10
11.												.27	.22	.16	.26	.04	.30	−.17
12.													.37	.26	.52	.39	.32	.38
13.														.36	.34	.43	.57	.31
14.															.37	.37	.42	.24
15.																.49	.30	.25
16.																	.42	.44
17.																		.53
18.																		
19.																		
20.																		
21.																		
22.																		
23.																		
24.																		
25.																		
26.																		

Strength Variables

1. Trunk Flexion
2. Trunk Extension
3. Trunk Lateral Flexion
4. Hip Abduction
5. Hip Extension
6. Trunk Rotation
7. Hip Flexion
8. Hip Adduction
9. Hip Outward Rotation
10. Hip Inward Rotation
11. Ankle Inversion
12. Ankle Eversion
13. Knee Extension
14. Knee Flexion
15. Ankle Dorsal Flexion
16. Ankle Plantar Flexion

Anthropometric: Intercorrelations of greatest magnitude were obtained among the anthropometric variables. Of the 45 such correlations, 31 (69%) reached significance at the .05 level of confidence; all but one were also significant at the .01 level and beyond. The highest correlation was .91 between leg length and standing height; leg length also correlated .88 with foot length.

TABLE 1 (Part 2)

Intercorrelations of Strength and Anthropometric Measures and Their Correlations with Selected Trunk and Leg Strength Criteria for College Men

19	20	21	22	23	24	25	26	C1	C2	C3	C4	C5	C6	C7	C8	
.21	.24	.32	.58	.63	.47	.39	.31	.51	.60	−.10	−.22	−.14	−.17	−.21	.13	1.
.05	.25	.23	.35	.43	.40	.19	−.02	.40	.44	.14	−.10	−.10	−.06	−.13	.08	2.
.31	.23	.27	.52	.51	.41	.42	.46	.50	.54	−.22	−.22	−.31	−.18	−.18	.02	3.
.08	−.07	.08	.30	.29	.17	.14	.26	.16	.11	−.05	.05	.05	.01	.08	.05	4.
.30	.04	.20	.36	.20	.22	.01	−.06	.25	.25	.15	.30	−.10	.06	.01	.01	5.
.36	.12	.23	.48	.40	.40	.21	.11	.37	.44	.06	.13	.06	−.09	−.23	−.07	6.
.17	.00	.11	.18	.16	.15	.03	.15	.20	.23	.11	.16	.03	.00	−.02	−.01	7.
.12	.34	.32	.37	.10	.02	−.05	.09	.22	.25	.08	.26	.05	.09	.02	.06	8.
.26	.17	.30	.42	.32	.29	.09	.07	.39	.28	.03	−.00	−.08	−.07	−.06	.21	9.
.14	.04	−.10	.23	.18	.04	.03	.14	.32	.41	−.10	−.07	−.06	.00	−.16	−.01	10.
−.06	−.20	−.14	.38	.42	.44	.21	.09	.13	.33	.03	−.02	.17	−.16	−.25	−.02	11.
.29	.34	.29	.33	.17	.17	−.05	−.05	.24	.42	.16	.19	.08	−.07	−.25	−.14	12.
.21	.31	.43	.63	.45	.33	.28	.44	.61	.55	−.09	−.04	−.03	−.13	−.04	.21	13.
.35	.09	.33	.54	.35	.19	.16	.22	.43	.29	−.04	.04	−.11	−.13	−.15	.06	14.
.29	.15	.11	.36	.22	.11	.02	.11	.30	.51	−.00	.11	−.05	.12	.02	−.08	15.
.38	.36	.37	.41	.29	.11	.13	.21	.37	.30	−.05	.01	−.13	.08	.01	.09	16.
.46	.44	.60	.87	.87	.74	.67	.63	.58	.64	−.09	−.34	−.34	−.25	−.25	.11	17.
.81	.91	.79	.63	.19	.14	−.01	.02	.37	.34	.00	−.02	−.27	−.13	−.05	.18	18.
	.42	.56	.71	.21	.09	.00	.04	.21	.22	−.03	.11	−.05	−.17	.05	.07	19.
		.88	.40	.13	.14	−.02	.01	.39	.34	.03	−.10	−.35	−.06	−.10	.22	20.
			.83	.35	.39	.15	.07	.40	.30	.13	.11	−.29	−.14	−.03	.15	21.
				.78	.65	.62	.58	.61	.64	.00	−.07	−.36	−.29	−.16	−.02	22.
					.73	.72	.65	.46	.52	−.14	−.41	−.20	−.22	−.12	.15	23.
						.57	.45	.32	.38	.01	−.35	−.10	−.31	−.23	−.05	24.
							.81	.32	.36	−.41	−.59	−.41	−.30	−.22	−.14	25.
								.35	.39	−.42	−.52	−.24	−.12	−.06	−.05	26.

Anthropometric Variables

17. Weight
18. Standing Height
19. Sitting Height
20. Leg Length
21. Foot Length
22. Hip Width
23. Thigh Circumference
24. Calf Circumference
25. Subcutaneous Tissue over Abdomen
26. Subcutaneous Tissue over Ilium

Trunk and Leg Criteria

C1. Back Lift
C2. Leg Lift
C3. Sargent Jump
C4. Standing Broad Jump
C5. Squat Jump
C6. Squat Thrusts (1 minute)
C7. Squat thrusts (12 seconds)
C8. Sit Ups (2 minutes)

Two tests had significant correlations beyond the .05 level with all of the other anthropometric measures, as follows:

1. *Body weight with:* hip width (.87), thigh girth (.87), calf girth (.74), adipose tissue over the abdomen (.67), adipose tissue over the ilium (.63), foot length (.60), standing height (.53), sitting height (.46), and leg length (.44).
2. *Thigh girth with:* body weight (.87), foot length (.83), thigh girth (.78), sitting height (.71), calf girth (.65), sitting height (.63), adipose tissue over the abdomen (.62), adipose tissue over the ilium (.58), and leg length (.40).

Other anthropometric intercorrelations significant at and beyond the .01 level were: .81 between adipose tissue over the abdomen and over the ilium and between standing height and sitting height, .79 between standing height and foot length, .73 between thigh and calf girths, .72 between thigh girth and adipose tissue over the abdomen, .65 between thigh girth and adipose tissue over the ilium, .57 between calf girth and adipose tissue over the abdomen, .56 between sitting height and foot length, and .45 between calf girth and adipose tissue over the ilium.

Strength intercorrelations: Of the 120 stregnth intercorrelations, 74 (62%) were statistically significant at the .05 level of confidence; 56 of these reached or exceeded the .01 level. The highest such intercorrelation was .65 between trunk flexion and extension; trunk flexion also correlated .58 with trunk lateral flexion. Other fairly high correlations were: hip inward rotation with ankle plantar flexion (.58) and with knee extension (.56), hip extension with trunk rotation (.57) and with ankle eversion (.51), hip flexion with hip abduction (.53) and with knee flexion (.50), hip adduction with knee flexion (.52), and trunk rotation with ankle dorsal flexion (.51).

The strength tests that had the largest number of intercorrelations significant at or beyond the .01 level were: hip outward rotation and knee flexion, 11 each; hip extension and trunk rotation, 10 each; and knee extension, 9. The strength test with the least number of significant intercorrelations were: hip inward rotation, 4; ankle inversion, 3; and trunk extension, 2.

Anthropometric-strength intercorrelations: Of the 160 intercorrelations between anthropometric and cable-tension strength tests, 72 (45%) were significant at the .05 level of confidence; of these, 42 reached significance at the .01 level. The highest such correlations were: trunk flexion strength with body weight (.64), with thigh girth (.63), and with hip width (.58); knee extension strength with hip width (.63) and with body weight (.57); trunk lateral flexion strength with body weight (.58), with hip width (.52), and with thigh girth (.51); knee flexion strength with hip width (.54); and trunk rotation strength with body weight (.50).

The anthropometric tests with the greatest number of significant correlations at and beyond the .01 level of confidence with the 16 strength tests were: hip width, 12; body weight, 8; thigh girth, 7; and calf girth, 5. Sim-

ilar results for the strength tests when correlated with the ten anthropometric strength tests were: trunk lateral flexion and ankle plantar flexion, 6 each; trunk flexion, trunk rotation, and knee extension, 5 each; and trunk extension and knee flexion, 4 each. The strength tests with no significant correlations with anthropometric tests were hip abduction, hip flexion, and hip inward rotation.

Correlations with back and leg criteria: Generally, correlations of the 26 anthropometric and strength variables with the eight trunk and leg criteria were low. Of the 208 such correlations, 58 (23%) were significant at the .05 level of confidence; 38 of these reached or exceeded the .01 level. Furthermore, 41 of the significant correlations were positive and 17 were negative.

Of the 41 positive correlations, 28 were significant at or beyond the .01 level. The highest correlations were obtained with leg strength, as shown in the following: .64 with body weight and hip width, .55 with trunk flexion and knee extension strengths, .54 with trunk lateral flexion strength, .52 with thigh girth, and .51 with ankle dorsal flexion strength. A number of relatively high correlations were also obtained with back-lift strength as follows: .61 with hip width and knee extension strength, .58 with body weight, .51 with trunk flexion strength, and .50 with trunk lateral flexion strength. Five variables correlated well with both leg-lift and back-lift criteria: body weight, hip width, and strengths of the trunk flexor, trunk lateral flexor, and knee extensor muscles.

Considering the 17 negative correlations between the experimental variables and the criteria, 11 were significant near or beyond the .01 level of confidence. The highest negative correlations involved standing broad jump and vertical jump, which correlated —.59 and —.41 with adipose tissue over the abdomen and —.52 and —.42 with adipose tissue over the ilium.

RELATIONSHIPS WITH CRITERIA

Back lift: The following 15 experimental variables had product-moment correlations with back lift that were significant at and beyond the .01 level of confidence: hip width and knee extension strength (.61); body weight (.58), trunk flexion strength (.51), trunk lateral flexion strength (.50), thigh girth (.46), knee flexion strength (.43), trunk extension strength and foot length (.40), hip outward rotation strength and leg length (.39), ankle plantar flexion strength, trunk rotation strength, and standing height (.37), and adipose tissue over the ilium (.35). The multiple correlations were:

	R	*Variables*
Anthropometry	.64	Hip width and foot length
Strength	.71	Knee extension, trunk extension, and knee flexion strengths
Strength and Anthropometry	.71	Knee extension strength, hip width, trunk extension strength, and knee flexion strength

Leg lift: Fourteen experimental variables had zero-order correlations with leg-lift strength that were significant at or beyond the .01 level of confidence, as follows: body weight and hip width (.64), trunk flexion strength (.60), knee extension strength (.55), trunk lateral flexion strength (.54), thigh girth (.52), ankle dorsal flexion strength (.51), trunk extension and trunk rotation strengths (.44), ankle eversion strength (.42), hip inward rotation strength (.41), adipose tissue over the ilium (.39), calf girth (.38), and adipose tissue over the abdomen (.36). The multiple correlations were:

	R	*Variables*
Anthropometry	.65	Body weight and hip width
Strength	.70	Trunk flexion, ankle dorsal flexion, and trunk lateral flexion strengths
Strength and Anthropometry	.74	Body weight, ankle dorsal flexion strength, and trunk flexion strength

Vertical jump: None of the cable-tension strength tests and only two of the anthropometric variables were significantly correlated with vertical jump. The two anthropometric variables, adipose tissue over the ilium and over the abdomen, however, had negative correlations: —.42 and —.41 respectively. The multiple correlation was .44 (with the axes of the adipose variables inverted).

Standing broad jump: One strength test, hip extension, correlated .30 with standing broad jump; this correlation is significant between the .05 and .01 levels of confidence. Five negative correlations, significant near and beyond the .01 level, were obtained with the anthropometric variables as follows: —.59 with adipose tissue over the abdomen, —.52 with adipose tissue over the ilium, —.41 with thigh girth, —.35 with calf girth, and —.34 with body weight.

The multiple correlation for the anthropometric tests was the same as the highest negative zero-order correlation with standing broad jump. When the strength and anthropometric variables were combined, a multiple correlation of .66 was obtained with adipose tissue over the abdomen (negative) and hip extension strength (positive) as the independent variables.

Squat jumps: Trunk lateral flexion was the only strength variable to correlate significantly with squat jumps; the coefficient was a low —.31, significant between the .05 and .01 levels of confidence. Three anthropometric variables had negative correlations with this criterion, significant around the .01 level, as folllows: —.36 with hip width, —.35 with leg length, and —.34 with body weight.

A multiple correlation of .54 was obtained with adipose tissue over the abdomen as the dependent variable (axis inverted) and with leg length and body weight as the independent variables. This multiple correlation is sig-

nificant beyond the .01 level. No increase in multiple correlation occurred when strength variables were included in the computation.

Squat thrusts for one minute: None of the strength tests were significantly related to squat thrusts for one minute. With this criterion, three anthropometric variables had negative correlations significant between the .05 and .01 levels of confidence: calf girth (—.31), adipose tissue over the abdomen (—.30), and hip width (—.29). The multiple correlation in this situation increased one point (.32), which, with three variables, is not significant at the .05 level.

Squat thrusts for 12 seconds: None of the strength and anthropometric variables were significantly correlated with squat thrusts for 12 seconds.

Sit-ups for two minutes: The correlations between all strength and anthropometric valuables and sit-ups for two minutes were not significant at the .05 level of confidence.

Summary

The purpose of this study was to determine the relationships of anthropometric and strength measures to physical performances primarily involving the trunk and legs of college men. The experimental variables were 16 strength and 10 anthropometric tests. Eight trunk and leg measures, involving dynamometric strength, muscular endurance, agility, and power, composed the criteria. The analysis of data was by zero-order and multiple correlational procedures. A summary of the results is as follows:

1. A number of intercorrelations among the anthropometric variables were especially high, as follows: standing height and leg length (.91); foot length with leg length (.88), hip width (.83), and standing height (.79); body weight with both hip width and thigh girth (.87); and adipose tissue over the abdomen and over the ilium (.81).

2. The intercorrelations among the strength tests were not as high, the highest being .65 between trunk flexion and extension.

3. In considering the significant intercorrelations between anthropometric and strength variables, body weight and hip width each appeared in four of these correlations; and trunk flexion and lateral flexion strengths were included in three each. The highest such correlations were .64 between body weight and trunk flexion strength and .58 between body weight and trunk lateral flexion strength.

4. The highest multiple correlations were as follows: .74, leg lift with body weight, ankle dorsal flexion strength, and trunk flexion strength; .71, back lift with knee extension strength, hip width, trunk flexion strength, and knee flexion strength; .66 standing broad jump with adipose tissue over the abdomen (negative) and hip extension strength (positive); and .54 squat jumps with adipose tissue over the abdomen (negative), leg length (positive), and body weight (positive).

5. None of the cable-tension strength tests were significantly correlated with vertical jump, squat thrusts for 12 seconds, or with sit-ups for two min-

utes. For the other criteria, the following low correlations were obtained: —.31 between squat thrusts and trunk lateral flexion strength and .30 between standing broad jump and hip extension strength.

6. A number of negative correlations were obtained between the following four trunk and leg criteria and anthropometric variables: standing broad jump, vertical jump, squat jumps, and squat thrusts for one minute. The highest of these were with the standing broad jump: —.59 with adipose tissues over the abdomen, —.52 with adipose tissue over the ilium, and —.41 with thigh girth.

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Swimming Power Test

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Abstract

An objective test of swimming power has been developed for the side stroke and front crawl. The reliability coefficients are .97 and .95 respectively, while the validity coefficients are .83 and .69 respectively. T-scores have been computed, based on the performance of 97 college women ranging in ability from beginning to advanced. The test promises to be as effective on the back crawl, breast stroke, and elementary back stroke.

SWIMMING has been one of the last fields to yield to objective measurement of skill. Very few of the textbooks on tests and measurement list any kind of a swimming test except to suggest the use of rating scales for form. It is not necessary to discuss the disadvantages of a form rating here.

One way of rating swimming skill would be to use a speed test. But when speed becomes the criterion for rating swimming, form is often neglected. Little correlation has been found to exist between speed and form ratings in swimming (3).

In rating a stroke, power is one of the important factors, while speed is not. It was decided, therefore, to attempt to set up an objective test based on this factor alone. If such a test should prove useful, it must cover strokes with a glide such as the side stroke, breast stroke, and elementary back stroke and also those strokes where there is continuous motion, such as the front and back crawl.

The purpose of this study was to set up a test which would measure the power of the side stroke and front crawl stroke.

Procedure

SUBJECTS

The subjects were college women registered in swimming classes or selected at random from those coming to swim in open hours at the pool in the Women's Gymnasium at the State University of Iowa.

PROBLEMS IN SETTING UP THE TESTS

There were a number of problems to be solved in setting up a test of swimming power. The value of a push-off from the side or bottom may be considerable. To make the test purely one of swimming, this help had to be eliminated. A rope was stretched across the pool on which the swimmer might rest her feet. This was fastened at one end and loose at the other. It was weighted in the middle by a brick suspended from a chain tied to the rope so that when the free end of the rope was dropped the brick pulled the rope down. Thus, the swimmer lost her support and started from a dead start in the water. The free end of the rope could be pulled taut for the start of the next swimmer.

[1] The author wishes to acknowledge the assistance of Mary R. Wylie and Ellen Vanderhoof in collecting and analyzing data.

Another problem that presented itself was the varying heights of the swimmers. If final measurements were taken at head height, and the starting measurement was from the ankles, the tall swimmers would have a slight but definite advantage. However, if initial and final measurement was taken at the feet, variation in height had no relation to the project.

Still another problem was which factor to standardize, the distance covered or the number of strokes. As it is difficult to estimate parts of a stroke quantitatively, it seemed logical to specify the number of strokes to be used and measure the distance covered. The length of the glide to be permitted presented still another problem. However, it was observed that if the swimmer held the glide too long she gained nothing because of inertia.

Certain other problems of form were taken care of by standardizing the directions. For example, a swimmer was not permitted to use a reverse scissors kick in the side stroke, or a scissors kick in the breast stroke, or to "ride" one arm in the front or back crawl. It was necessary also to inform a swimmer that any propelling movement such as an extra kick at the beginning would be counted as a stroke regardless of whether it was a complete stroke or not.

EQUIPMENT

A rope approximately 20 feet longer than the width of the pool should be tied at one end to some firm object. The other end should be free. A weight should be suspended from the center of the rope so the rope will drop when the free end is released. It should be possible to pull the rope up, so that it is about one foot below water level at the point where the swimmer starts. The rope should be suspended approximately two feet from the end of the pool and parallel to it.

Starting at the rope level, the deck of the pool should be marked off in 5-foot intervals with adhesive or masking tape. It will be easier to estimate distance if the 10-foot interval markers are longer than the 5-foot markers. Intervals up to 55 feet should be marked. Markers should be numbered for ease of measurement.

TEST DIRECTIONS

The starting line is pulled taut enough so that it is about a foot under the water level at the point the swimmer is to start. The swimmer assumes the appropriate floating position for the stroke, i.e., side float for side stroke, face float for front crawl or breast stroke, and back float for elementary back stroke or back crawl. Her feet rest on the rope with the malleoli at rope level.

At the signal go, the rope is dropped, thus depriving the swimmer of her support, and the swimmer starts stroking. In swimming the side, breast or elementary back stroke, a swimmer does five strokes complete with glide. The distance covered is measured by noting where the ankles are in reference to the deck markers at the beginning of the recovery of the legs for the sixth stroke. Distance to the nearest foot is noted.

For the crawl and back crawl, the distance covered is measured by noting where the ankles are at the moment the fingers enter the water to begin the

sixth complete arm cycle. This can be simplified by counting the point of entry of each arm as one unit. It is then at the 11th entry that the measurement is taken.

There are several precautions that need to be observed to make the test as objective as possible. Care must be taken that the swimmer does not drift from the starting position and drag the starting line with her. To gain full advantage from the glide of a stroke the swimmer should be instructed to swim at least six strokes. The tester should check the starting position and then follow the swimmer and place herself even with the swimmer's feet at the end of the fifth stroke.

To become oriented with the starting position, all swimmers should experience starting from the rope two or three times before actual trials are taken. It is not necessary for them to have trials before each different stroke; if the practice trials start in different positions, that is sufficient.

Swimmers should be told that they will be stopped and the trial will not count if they use a reverse scissors on the side stroke, a scissors kick on the breast stroke, or if they do not keep the arms in continuous motion on the front and back crawl. A trudgen kick is not permitted on the front crawl trials.

Any propelling movement such as using a kick before starting the arms counts as one stroke.

STATISTICAL PROCEDURE

Reliability coefficients were computed by correlating the scores of the various trials on the test. The first trial was correlated with the third and the second with the third using the Pearson Product-Moment Method (5).

It was assumed that the test had face validity. However, one testor decided to check on the validity of this as compared with subjective ratings. The ratings of the swimmers were done previous to administering the test and were not done originally to be used in establishing validity coefficients. However, as the scores were available, the two sets of data were correlated.

The judge was an experienced teacher of swimming who had taught the classes she tested for approximately eight weeks. The classes were beginning swimming classes which had met twice weekly for periods in the water of one hour and 20 minutes each. The judge had had experience in judging form swimming in meets and had worked with two other experienced judges, including the author, in judging form swimming in previous sessions in which there was a considerable unanimity of opinion in grading the various individuals using the flash card method.

The side stroke and front crawl strokes were rated on a ten-point scale with the addition of plus and minus signs. These ratings were not broken down to allocate a certain number of points to each body part but were an over-all judgment of the stroke. The ratings were then transcribed into another scale as follows: nine plus became 96 and nine minus became 90. A six plus would then become 66, a six would become 63, and six minus would become 60.

Data were collected on over 50 subjects for the validity coefficients which were computed using the Pearson Product-Moment Method.

The norms for the side stroke and crawl stroke were computed from actual data on 97 swimmers using the McCall Method (5).

Analysis of Data

Fifty subjects ranging in ability from beginners through advanced swimmers were used to check the reliability of measurements for the front crawl and side stroke. Three trials were given each subject, and data were collected on all three trials. The results are found in Tables 1 and 2.

TABLE 1
Mean Scores for Side Stroke and Front Crawl Stroke

N = 50	Mean	Standard Deviation
	(*Feet*)	(*Feet*)
Side Stroke		
Trial 1	28.42	8.46
Trial 2	28.90	8.58
Trial 3	28.42	8.66
Front Crawl		
Trial 1	27.74	5.68
Trial 2	27.50	6.40
Trial 3	28.06	6.12

TABLE 2
Reliability Coefficients for Side Stroke and Front Crawl Stroke

N = 50	Side Stroke r	Front Crawl r
Trial 1 vs 3	.96	.87
Trial 2 vs 3	.97	.95

As a test of swimming power, it is not necessary to validate the test, since face validity can be assumed. However, if one wishes to compare power scores and form ratings, the test appears to be valid enough to be used in place of a form rating (see Table 3). It appears to function better for a stroke with a glide than for one with continuous motion. It may be that power contributes more to the over-all impression of form in a resting or gliding stroke, such as the side stroke, than it does in the crawl.

TABLE 3
Validity Coefficients for Side Stroke and Front Crawl Stroke

Stroke	N	r
Side Stroke	57	.83
Front Crawl	56	.69

T-scores have been computed for the crawl and side stroke, based on data from 97 college women (see Table 4). Using actual data, rather than smoothing the curve to give an ideal distribution, accounts for the apparent dis-

TABLE 4
T-Scores for Crawl and Side Strokes
(N = 97)

T-Score	Crawl	Side Stroke	T-Score	Crawl	Side Stroke
	(*Feet*)	(*Feet*)		(*Feet*)	(*Feet*)
76	50	52	51	27	28
73	47-49	51	49	26	26-27
72	46	50	48	25	25
70		48-49	47		24
69	45	46-47	46	24	
68	44	45	45		23
67	43	44	44	23	22
66	40-42	43	43		21
65		42	42	22	
64	39		41	21	19-20
63		40-41	40	20	18
62	38	37-39	39		17
61	36-37	36	38	19	16
60	35	35	37		15
59	34	34	36	18	
57	33	33	35	17	14
56	32		34		9-13
55	31	32	33	16	8
54	30	31	32		7
53	28-29	30	30	15	6
52		29	27	9-14	
			24	8	5

crepancy between the deciles in the T-scale. A smoothed curve would have assigned decile scores one standard deviation apart. There is a slight deviation because of the distribution of the raw scores.

Summary and Conclusions

A test of swimming power for the front crawl and side stroke has been developed and found reliable and valid enough for use with individuals. The test has been used at all levels of ability from beginners through advanced.

Preliminary work with the test on the back crawl, breast stroke, and elementary back stroke indicate that the test will probably be reliable and valid for those strokes also.

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(Submitted 2/28/57)

Selection and Standardization of Speed Tests

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Abstract

Many tests of the speed factor in fitness have been used. Herein we describe tests found unsatisfactory in order that others may profit from our findings. The 60-yard run, in addition to providing a speed test, was used as the exercise for the pulse recovery test. Originally, it was the short run for the drop-off score, too. It was timed in .01 minutes because this increased the number of frequency classes and, furthermore, facilitated the calculations of the drop-off score.

SINCE 1941, 4-H club members in Illinois have engaged in certain motor fitness activities as a part of their health program. Motor fitness is defined as the ability to perform the more vigorous muscular activities which demand balance, endurance, flexibility, speed, and strength. This report is limited to a description of the procedures used in selecting and standardizing the speed tests. The tests were administered each year at county field days and the scores were used in combination with other scores to show the present level and the improvement in overall fitness made from year to year. The total keeping-fit activity has been described elsewhere (2, 3).

Scores on speed tests usually show rapid gains with practice and this according to Steinhaus (5) is the result of the development of motor co-ordination. This he described as the body's ability to mobilize nervous energy and to regulate its distribution to the muscular tissues. The later improvement shown on runs comes about as the respiratory, cardiac, and vasomotor centers are prepared in anticipation for and become efficient in continuing these activities.

More than 25,000 boys and girls ranging between 10 and 20 years of age have been tested. Certain tests proved inadequate and were discarded.

Because the tests were to be as measures of motor fitness, those which called upon the large muscle groups of the legs and trunk were chosen.

Procedure

Shuttle run. The first test consisted of six shuttle trips along one side of a 30-foot equilateral triangle, followed by running along the perimeter. It was scored in elapsed time. The testees tended to circle at the turn points rather than make abrupt changes in direction and they had difficulty in keeping count of their shuttle trips. The scores showed no differences by age or by body type ($3\sqrt{}$ weight/height). This did not seem reasonable. Furthermore, the test took too much time to administer. Even though the test could be

run in a small area, it was abandoned in favor of the course shown as Figure I.

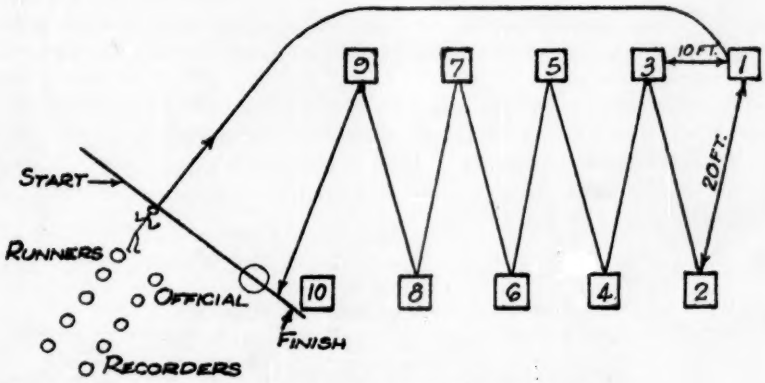

FIGURE I. Group Shuttle Run with Ten Bases.

Ten persons were lined up in a file of two's. In the left-hand file were the runners, in the right file the recorders. The first runner lies face down at the starting line and starts at the signal "go." The official counts continuously in .01 minute intervals. The second runner starts at count 10, the third at 20, the fourth at 30, and the fifth at 40. The official continues to count until all have finished. The recorder for each pair catches the count when his partner finishes and determines his score by subtraction.

The first bases were wooden 8-inch discs spiked to the ground. These were often skipped by runners. Later, a one-half inch iron pipe 18 inches long was driven through the base and a number attached to its top. This enabled the runner to find the base easier, but it presented the hazard of falling upon the pipe. Finally, the heavy iron base shown in Figure II was designed. It was firmly spiked down and the runner was instructed to hit each base with his foot, change his direction abruptly, and follow the lines

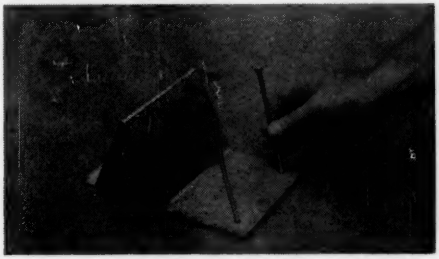

FIGURE II. Metal Base.

as indicated in Figure I. Instead, he more often circled the bases without any abrupt change in direction. Frequently a runner missed a base.

Speed tests usually give normal or near normal distributions. This test gave a skewed distribution with a long tail extending toward the higher scores. The curve resembled endurance run curves, but the test took less than .5 minutes.

When the scores were tabulated by age, a typical S-shaped growth curve was shown. These data were fitted to the isochronic growth curve (1) and the predicted values are shown in Table 1 along with actual scores. It was decided to abandon this test in favor of a straight-away run, which took less equipment and less instruction.

TABLE 1
Actual and Predicted Mean Scores for Shuttle Run

Age in Months	N	Means for boys in .01 minutes		N	Means for girls in .01 minutes	
		Actual	Predicted[1]		Actual	Predicted[1]
250[2]	5	.370	.374			
240	26	.369	.377	3	.480	.449
230	42	.380	.380	6	.481	.450
220	45	.384	.384	16	.458	.451
210	72	.386	.389	45	.446	.453
200	149	.391	.394	80	.457	.455
190	223	.400	.401	139	.455	.458
180	264	.409	.408	234	.464	.467
170	328	.420	.416	333	.465	.465
160	423	.427	.426	471	.469	.470
150	424	.439	.436	526	.478	.476
140	394	.447	.447	502	.483	.482
130	383	.459	.458	516	.486	.489
120	285	.471	.470	436	.496	.496
110	40	.474	.481	43	.493	.503
100	6	.488	.491	7	.508	.509
Totals	3109			3357		

[1] The predicted average score was calculated according to the simplex isochronic equation, and the fit was satisfactory. See Reference 1.
[2] Lower limits of age groups.

Sixty-Yard run. Prior to 1945 the 100-yard run was used as a speed test. It was also used in connection with the 1000-yard run to calculate a drop-off score. Because so many testees refused to run 1000 yards, we changed to the 60-600 yard combination for the drop-off and used the 60-yard run as a speed test too.

The correlations between the shuttle run and 60-yard run were .607 for boys and .460 for girls. These may indicate two different types of tests, or they may show the difficulties certain runners had in finding the bases on the shuttle run.

The official timer for the 60-yard run stood at the finish line and started each runner by dropping a flag. Many boys and girls having had no prior instruction in running failed to go all out. In order to motivate them, the timer was changed to the starting line and a flag was erected at the finish line which was tripped when the tape was broken. Because testees had little skill in starting, they were given a running start and the watch was started when they passed the starter.

In 1953, an electric timer was built, with both starting and stopping gates. This reduced the chances of error in timing.

Analysis of the Data

The 60-yard distribution by score classes described a near normal curve. The age distribution showed decreasing scores as age increased. The actual and predicted values are shown in Table 2.

TABLE 2
Actual and Predicted Mean Scores for Sixty-Yard Run

Age in Months	N	Means for boys in .01 minutes		N	Means for girls in .01 minutes	
		Actual	Predicted[1]		Actual	Predicted[1]
230[2]	97	.128	.123			
220	130	.127	.127	45	.170	.163
210	220	.131	.130	125	.166	.163
200	361	.135	.132	253	.164	.164
190	576	.138	.138	426	.165	.164
180	741	.143	.144	658	.165	.165
170	915	.149	.150	940	.166	.166
160	1148	.155	.155	1348	.166	.168
150	1223	.160	.160	1583	.170	.170
140	1220	.164	.164	1549	.173	.173
130	1120	1.69	.169	1584	.177	.178
120	866	.174	.173	1253	.182	.182
110	88	.176	.180	154	.183	.189
Totals	8705			9918		

[1] The predicted scores were fitted to the isochronic growth curve. The fit was satisfactory. See Reference 1.
[2] Lower limits of age groups.

Although these scores show a satisfactory growth curve, they are not as good as we have reason to expect when compared with the time made by good runners. This is made clearer by an examination of the standard scores.

Since the actual scores fit the isochronic equation according to limits set up by Courtis, the predicted scores were used in calculating the standard score tables. The predicted curve for boys was a two-cycle curve with the maximum at .126 minutes at age 270 months. For girls, the predicted curve was a single cycle curve with maximum at .137 minutes at 210 months of age. That there was no second cycle for girls may be related to sex or to social pressures against running for girls.

Using the predicted scores by ages, the standard score tables were calculated as six standard deviations plus and minus the mean. This gives tables of scores comparable regardless of age or sex, with a mean score of 50 and a range of 1 to 99.

Tables 3 and 4 show that the best boys and girls in these groups do very well on the 60-yard run in comparison to record runners. But the average scores for age groups seem too low, and the slowest runners have done but little better than trot the distance. This emphasizes the difficulties of setting up any standard based upon the population distribution. In this case, the standard deviation seems too large, and this tends to down-grade the scores. If the 60-yard run is to be a measure of fitness, we should have a fit population as the basis for comparison. This problem might be solved, if we knew how small the standard deviation should be and then used that and the top scores to determine the distributions by age groups. This problem is

TABLE 3
Standard Scores for 60-Yard Run for Boys

Raw Scores in .01 min.	Age in months[1]											
	120	130	140	150	160	170	180	190	200	210	220	230
.08												99
.09									97	99	99	89
.10							99	95	86	88	89	77
.11					97	93	88	83	75	76	74	65
.12	99	97	94	91	87	82	77	71	63	63	60	54
.13	91	88	84	81	76	72	66	60	52	50	46	42
.14	81	78	74	70	66	61	55	48	41	37	31	30
.15	72	69	64	60	55	50	43	36	30	24	17	18
.16	62	59	54	50	45	39	32	24	19	11	3	6
.17	53	49	44	40	34	28	21	12	8	1		
.18	43	39	34	30	24	18	9	1				
.19	34	29	24	19	13	7						
.20	15	20	14	9	3							
21	5	10	4									
.22		1										
S.D.	.018	.017	.017	.016	.016	.015	.015	.014	.015	.013	.012	.014

NOTE: The N's and Mean's are found in Table 2. The raw scores may be converted to seconds by multiplying by 60.
[1] Lower limits of age classes.

being attacked by an examination of the pulse recovery scores which have been taken immediately after the 60-yard run. Until this problem is solved, the present standard score tables will have to be used.

Since standard scores are comparable regardless of age and sex, they may be used to show improvement made by persons from year to year, or to show differences resulting from different methods of training or different county programs.

TABLE 4
Standard Scores for 60-Yard Run for Girls

Raw Scores in .01 min.	Age in months[1]									
	120	130	140	150	160	170	180	190	200	210
.11							98	95	95	93
.12			96	98	95	93	89	87	87	85
.13	99	95	88	89	86	84	80	79	79	77
.14	90	85	79	79	76	74	72	70	70	69
.15	80	76	70	69	67	65	63	62	62	61
.16	71	67	61	60	58	56	54	53	53	52
.17	61	57	53	50	48	46	46	45	45	44
.18	52	48	44	40	39	37	37	37	37	36
.19	42	39	35	31	29	29	28	28	28	28
.20	33	29	26	21	20	18	20	20	20	20
.21	23	20	17	11	10	9	11	11	11	11
.22	14	11	9	2	1	1	2	3	3	3
.23	4	1	1							
S.D.	.018	.018	.019	.017	.018	.018	.019	.020	.020	.021

NOTE: The N's and Mean's are found in Table 2. The raw scores may be converted to seconds by multiplying by 60.
[1] Lower limits of age classes.

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(Submitted 2/19/57)

Comparison on Statistical Basis of Achievement in Track and Field Events

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Abstract

When the cumulative frequency of the best hundred results of a number of track and field events each year is plotted on a log-log scale, a straight line is generally obtained. Though this distribution is formally similar to the Pareto distribution, which, e.g., describes the distribution of income, the coefficient b of the regression equations is much larger in the sports, from −16 to +116, than in the distribution of income, where it is approximately −1.5. The distribution of athletic ability thus comes nearer to a semi-log relation.

A high value of b means that the difference between the result of the best and the 100th man is small in relation to the total time used, centimeters jumped, etc., and vice versa. The highest values of b were obtained in events—like 100-meter and 800-meter runs—in which the result is evidently determined to a large extent by relatively few physiological factors, like the speed of muscle contraction, maximum oxygen uptake, or oxygen debt. The lowest values of b were associated with such events in which the contribution of the central nervous system becomes more dominant, either due to the necessity of long-term training—long distance running—or to the intricacy of movements—jumps, throws.

The frequency of each result in an event may be used as a measure of its "value." In this way, results attained in different events may be made comparable on an objective basis.

IN ALL track and field events, an athlete's result can be expressed by an exact figure, be it time or length. However, though it is known how many centimeters two results attained in some event differ, the "value" of the difference cannot be immediately stated in quantitative terms. Further, two results attained in different events cannot at all be directly compared. However, both these comparisons are interesting, being also a necessary basis for calculating the combined result of competitions such as the decathlon. For this purpose, several systems of assessing points or standard values to the results of track and field events have been developed.

If one is dealing with a limited group, the distribution of the results, i.e., the frequency of results on different levels, attained by the members of the group, can be determined. Assuming so-called normal or Gaussian distribution of the results, the mean and the standard deviation may be used as a basis for the valuation of the results. A system which has been widely employed is to use a scale from 0 to 100 covering the range of mean $\pm 3 \times$

standard deviation. Owing to the form of the normal distribution, most results come close to 50, and few near to 0 or 100.

This method cannot be used when one has to compare the best results in different events attained in a country or in the world as a whole. The group of athletes from among whom the best results come, cannot in this case be defined. The group evidently is not the total population of the world, nor the collection of athletes participating in the most contests, but it is impossible to judge how large a fraction of the total population it would be. Only good results are recorded, and there is no record of the achievements of those who do not enter important competitions.

As there has nevertheless existed a need for a point system for the comparison of top class results, e.g., in the decathlon, point systems have been created on an empirical basis. For example, the International Amateur Athletic Federation has recently published new scoring tables (4). In the case of runs, these tables have been prepared on the basis of statistical observations concerning the dependence of the average speed of the runner for the distance; it is well known that at different distances different optimum average speeds are to be kept. Certain average speeds are taken as comparable, or of "equal value," which procedure enables one to assess "values" for different results in each running event. In case of throwing and jumping events, the procedure applied is not exactly described in the foreword of the Scoring Table, but it is stated: "A corresponding principle to that for running races has been applied in working out the tables for throwing and jumping events." It seems that preparation of those latter tables is based mainly on experience and subjective evaluation of the "value" of results of different levels. As the publishers of the *Scoring Tables* put it: "It is of course a very difficult matter to compare quite accurately performances in different events, but in the present table an endeavour has been made to make this comparison as fairly as possible. In the case of a comparison of this kind, more or less emotional factors often play a part, and it will probably be considered practically impossible to arrive at a scoring table which is satisfactory from every point of view."

There is a possibility to evaluate the "goodness" of a given result by noting the *frequency* of performances equal to or better than that result. Intuitively, it is felt that the rarer the result, the "better" it is. This line of thought has been followed in the present investigation.

If top performance records with sufficient coverage are available, as is now the case in athletics, the frequency of results passing any given limit, which is not too low, can be observed. In each sports event separately, decreasing frequency of performances indicates, of course, improving results. Any result achieved or passed by only ten athletes is better than a result which has been achieved or passed by 100 athletes. Further, those results in different events which have been achieved or passed by ten athletes in each event separately, are, in a sense, comparable, in that they seem to be "equally diffi-

cult" to be attained. Similarly, results in different events achieved or passed by 100 athletes in each are comparable with each other.

These considerations have led the authors to accept, as an *objective basis of comparison, the frequency of different results.* This basis can be described objective in the sense that whoever is in charge of evaluation always comes to the same evaluation result, for the frequencies are given. However, because of statistical random variations in occurrence of top results, modifications in the evaluation process are necessary in order to prevent purely chance variations from playing an unduly important role. Such modifications, statistical-mathematical in character, will shortly be discussed.

The results are generally improving year by year. Therefore, the present study deals with periods as short as one year only. If the level of top results in some event will markedly improve, on the basis of introduction of new techniques or new training methods, the frequency scales have to be readjusted. Thus, a frequency scale is intrinsically no more permanent than an empirical scale, but it is likely to represent the actual situation in an objective light, whereas an empirical scale may do it only by chance. Further, necessary adjustments in the course of time concern only the numerical values of constants involved in equations which will shortly be given, whereas the mathematical nature of evaluation remains unaltered.

Material and Method

The study covers the year 1949-53, and for each year 17 track and field events. A list of the best results of about 100 best athletes in each event and year was obtained from the statistics of the *International Athletics Annual* (5). The cumulative frequency of the results, i.e., the number of performances equal to or better than given results, was plotted on a graph. The results in each event are marked on a logarithmic scale along the abscissa, and the cumulative frequency similarly put on a logarithmic scale along the ordinate. The vertical position of a point on the graph thus shows how many men attained a result as good as, or better than, the corresponding point on the abscissa.

The reason for adopting the log-log plot instead of other possible forms was the authors' original surmise that the distribution of top level achievements might follow the Pareto law which will shortly be discussed. Additional reasoning is found in the fact that graphical analysis is made easier, in particular concerning the few top results, if the axis indicating the frequency is elongated toward smaller figures, as is the case in log-scale. Further, the use of a log-scale for the result axis renders the numerical values of results comparable in the sense that a given proportional change of result is always shown equally long, whatever the event, and whether the result is expressed in units of time or length. In using common arithmetical scales, a risk is run of obtaining misleading relations between the graphic illustrations of different events, as the scale can be selected at will. By employing the log-scale, such a risk is eliminated.

Results

An examination of the graphs shows that in most events the distribution of the results tends to be linear when plotted in the way described (Fig. I). Minor irregularities occur, of course, in some of the events and in some years. However, there are also events in which a tendency to a curvilinear

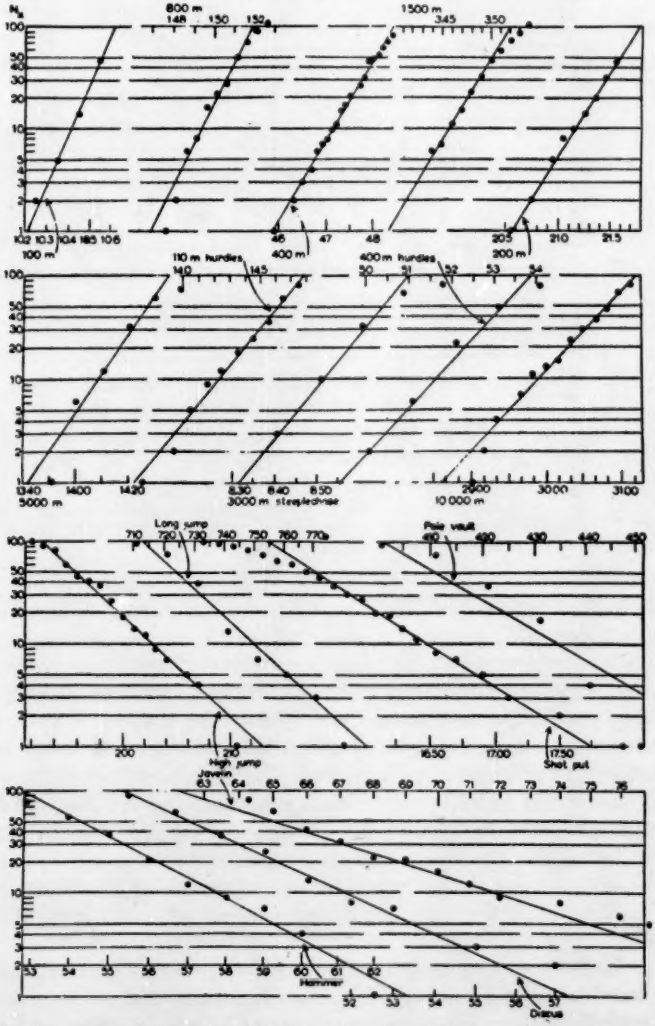

FIGURE I. Cumulative frequencies (dots) in 1953 of world top results together with eye-estimated distribution curves (straight lines). Log-log plot.

log-log distribution occurs. Such events are, for example, 1,500 m. and 5,000 m. races, 3,000 m. steeplechase, pole vault, and shot put (Fig I). In the large majority of events, however, there is no systematic deviation from a linear log-log plot.

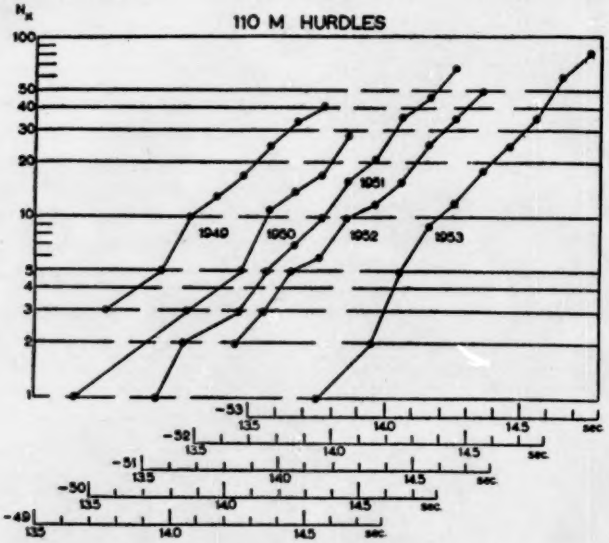

FIGURE II. Cumulative frequencies in 1949-53 of world top results in 110 m. hurdles. Log-log plot.

These observations have led the authors to draw straight lines in such a way that they will fit with the observed frequency points, i.e., so that the lines would represent a "true" frequency curve. Because of random variations, some observed frequency points are above such a line, some below. In drawing the lines, little attention was paid to the few, say 3 to 5, top performances, for these frequencies are subject to relatively large statistical variations. Thus, frequencies from some 5 or 10 to some 50 or 100 were generally considered decisive in determining the course of the line. On the other hand, if a curvilinear log-log relation was apparent, only the tail part of the curve, usually nearly linear, was graduated. In such cases, evaluation on the basis of the line drawn cannot be extended beyond frequencies of about 50, i.e., beyond results worse than those attained or passed by at most about 50 athletes.

All the lines presented were drawn by eye. Although exact statistical-mathematical methods are available for calculating the position and direction of the lines by applying regression analysis, it is felt that for purposes of presenting the principle, the eye method is sufficient, in particular since the

freshest material used is nearly three years old and since the authors aim at an exact treatment of the 1955 results in another paper.

A comparison of the distribution of the results in subsequent years shows that in general the distribution does not vary much from year to year. Figure II, 110 m. hurdles, gives a typical example of little variation with time. The most marked variation from year to year was observed in the high jump, as seen in Figure III.

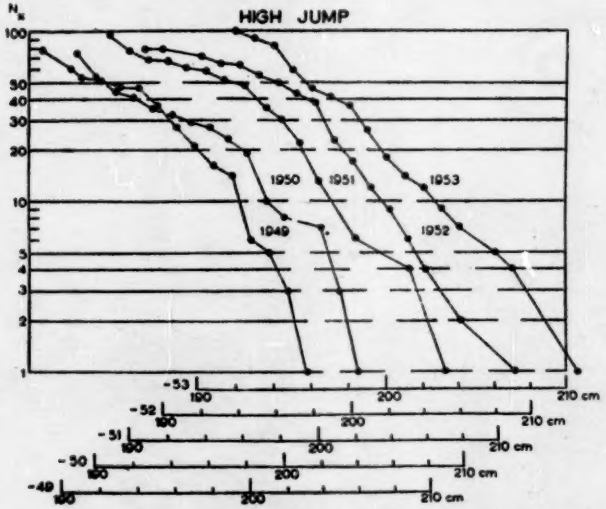

FIGURE III. Cumulative frequencies in 1949-53 of world top results in high jump. Log-log plot.

The graphs in Figure I were drawn in such a way that the slopes of the lines for different events are comparable, i.e., the modulus of the horizontal logarithmic scale was kept constant. The steeper the line, the more sharply achievement of better results in the event becomes less probable—or more difficult. The less steep the line, the wider the variation among the best athletes in the event.

Table 1 gives a list of the slopes. In the final preparation of the present study, the slopes were determined solely on the basis of 1953 data, though in most events the same slope would have been obtained from the data of any of the years 1949-53.

Finally, Figure IV shows a comparison of the results in different events for 1953. Results with the same average frequency or probability are shown above each other. The abscissa is for each event on a log-scale, now with varying length of modulus. This graph can be considered as a basis for an objective comparison of the top track and field results of the year 1953. In order to illustrate the relation of this objective scale to the officially accepted

TABLE 1.

Approximate b-coefficients in regression equations for prediction of cumulative frequencies of results.

General form of equations: log (cumulative frequency) = constant + b log (result)

Event	Regression coefficient b
100 meters	116
800 meters	100
400 meters	85
1,500 meters	84
200 meters	82
5,000 meters	72
110 m. hurdles	61
3,000 m. steeplechase	60
400 m. hurdles	53
10,000 meters	52
High jump	—46
Long jump	—46
Shot put	—31
Pole vault	—29
Hammer	—26
Discus	—23
Javelin	—16

point system (4) the results given 1,000 and 1,500 points according to the official system in each event are also marked on the graph. The official scale does not generally come close to the "objective" scale of the authors. Most marked differences between the scales are observed in 100 m., 800 m., and 1,500 m. runs, but also in other events definite differences exist both in the "location" and the "breadth" of the scales.

Discussion

MATHEMATICAL CHARACTERIZATION OF THE OBSERVED DISTRIBUTION

Mathematically, the straight lines described in the foregoing can be expressed by the formula

$$\log N_x = a + b \log x \qquad 1.$$

or

$$N_x = Ax^b, \qquad 2.$$

where

N_x = number of athletes achieving at least the result symbolized by x, i.e., the frequency of such results,
x = result,
a = constant of location,
b = constant of slope, indicating the slope of the straight line in log-log plotting,
$A = e^a$, e standing for the base of natural logarithms.

It is noteworthy that this formula, with the constant b assumed to be approximately equal to —1.5, was by Pareto[1] observed to be suitable in describing distribution of income in human communities of mixed nature (1). Accord-

[1]V. Pareto, as cited by Davis (1).

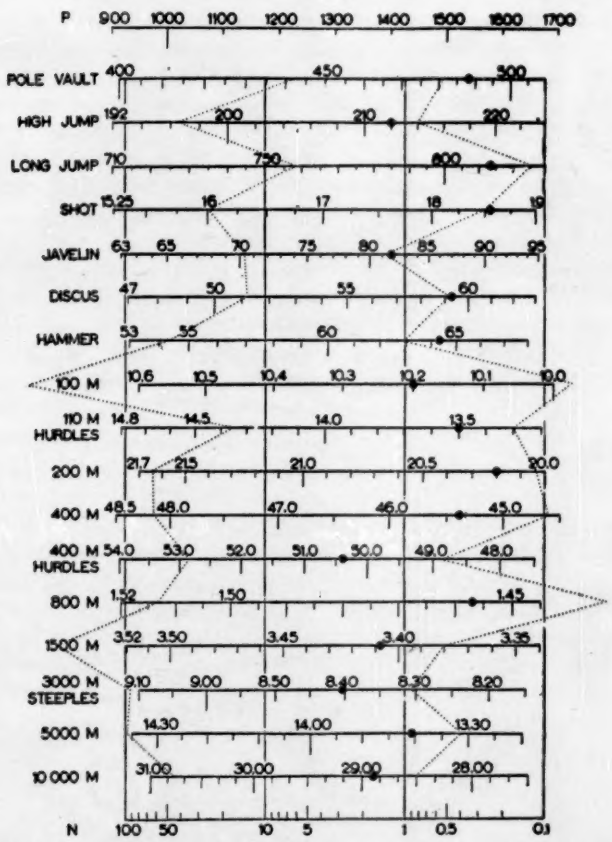

FIGURE IV. The results of 1953 in different events made comparable by "equalizing' results which occur with equal frequencies. N = cumulative frequency of results (= number of results equal to or better than that shown on the appropriate result scale). Uppermost, the suggested new point scale, in which 1,500 points are allocated to a performance which was likely to be obtained by 0.5 athletes in 1953, and 1,000 points are allocated to a performance which 50 men exceeded. The pointed line connects the performances to which the 1955 'official" point table allocates 1,000 and 1,500 points respectively. The zigzagging of the latter lines demonstrates a poor fit with the "objective" points allocation.

ingly, the distribution characterized by 1 or 2 has since been called the Pareto distribution. On the basis of extensive statistical materials over a long range of time, it is now universally accepted that for some reason or other the people in any community tend to be distributed by income according to the Pareto law, i.e., that the frequency of people passing any sufficiently high income level is, on an average, expressed by the formulas 1 or 2.

To return to the present problem, the frequency distribution of top level sports achievements reported in the foregoing resembles much the Pareto law, save for the numerical value of the b-coefficient.

This mathematical-historical basis led the present authors to test the linear log-log relation to describe the frequency distributions studied. However, it is necessary to point out that the resemblance with the Pareto distribution is only of formal nature; the mathematical equations to be applied are similar, but the vital constant b is of different order of magnitude. The original Pareto distribution assumes b to be approximately equal to -1.5; other applications of formula 4 assume values of the order of magnitude of -2 or so, whereas b in the present material varies from -16 to $+116$. In simple words, the log-log relation as described above is not so much a log-log relation as a semilog-relation. A very good approximation for the distribution of top results seems to be, instead of formulas 1 or 2, the following:

$$\log N_x = a + bx \qquad 3.$$

or

$$N_x = AC^x, \qquad 4.$$

where

$$C = e^b,$$

the symbols being as previously mentioned.

A possible alternative to the Pareto law or to the semilog-relation in 3 and 4 is the so-called normal distribution, or the Gaussian law. For sufficiently high levels, e.g., according to Feller (2), this alternative results in

$$\log N_x = \log N - \tfrac{1}{2}\log 2\pi - \log z - \tfrac{1}{2}z^2, \qquad 5.$$

where

N = total number of "competitors,"
$z = (x\text{-}\bar{x})/\sigma$ = normalized result,
σ = standard deviation of results,
$\bar{x}$ = average result,
$\pi = 3.14\ldots$

Evidently, verification of this alternative would lead to procedures which are from the point of view of labor required far beyond those reasonable in connection with a preliminary report. It should be clear that the constants involved, N, $\bar{x}$ and σ, are not known and that the estimation of them on a trial and error basis would be a hopeless task.

It is to be noted that the partial derivative of the function (formula 5) on log z is, save for a constant, proportional to log z, which means that the function cannot be represented as a straight line in the log-log plot actually used. Therefore, if linearity of the log-log relation is apparent, this second alternative is not very likely, though it is not impossible, provided that the x-values under investigation are very large in comparison with the unknown mean $\bar{x}$.

PHYSIOLOGICAL INTERPRETATION OF THE RESULTS

Running events show a continuous series of slopes. The 100 m. run line is steepest, the 10,000 m. run line least steep (Table 1). After 10,000 m.

come 400 m. hurdles, 3,000 m. steeplechase, and 110 m. hurdles. A steep line means that, in terms of the results, the best and the hundreth best man are relatively close to each other.

If the population of runners in the world is looked upon as an entity, an *increase in the slope* of a performance could be regarded as an *approach* to the direction of an *"all-or-none" reaction.* The steeper the line, the nearer the ideal situation is approached in which all men would do the same thing equally well, when using their maximum motivation. On the other hand, a small slope indicates that in such a performance men tend to be rather different from each other.

Developing this reasoning further the assumption may be made that such performances in which men tend to be like each other are essentially based on a similarity in the physical and mental constitution of man. The anatomical constitution and the innate physiological functions tend to differ relatively little from man to man. However, if a performance is not determined by a single anatomical or physiological factor, but by a combination of factors, the range of the results of performances is bound to increase. The combination of two favorable characteristics is considerably more rare than the occurrence of each determinant alone, and a combination of three maximally favorable characteristics is rarer still. Nevertheless, such combinations do occur when the population is large enough.

Thus, an important factor tending to *decrease the slope* of the distribution of the best athletic results is the *multiplicity of the determinants of the performance.* The concept of the multiplicity of the determinants may be extended from anatomical and physiological characteristics to other realms. *Training* is essential for all athletic performances. In training, the analogy to multiplicity of determinants would be the *effort and time needed* for training. The more the performance in an event may be improved with the aid of training, the less steep a distribution is to be expected.

In the type of *movements* the multiplicity of the determinants evidently means more complex *central nervous system control.* Delicate co-ordination of different muscle groups—as in the pole vault—obviously poses much greater requirements on the motor centers than repetition of simple movements like running which comes to man as a heritage from his primitive ancestors. The multiplicity of determinants in the central nervous system is not solely connected with the amount of training required. The more skilled motor control the event requires, the wider a range is to be expected.

An examination of the results from this angle indicates that achievement in throwing and jumping events is determined by more multiple factors than that in runs; a result with which common sense will agree. Throwing events have a wider range than jumps; accordingly, throws probably are less determined by innate physiological characteristics than are jumps. This fits well also with the age distribution of throwers and jumpers. Throwers are, on an average, older than jumpers, and they also have a wider age range (6).

Thus, throwing events are less closely dependent on such—probably physiological—characteristics which are age-bound.

Among the runs 100, 800, 400, 1,500 and 200 meters are those having the narrowest ranges. The achievement in these events is known to be essentially determined by a few physiological factors. Such are the speed of leg muscle contraction in the sprints, ability to build up an oxygen debt, and maximum oxygen uptake at longer distances, as shown already by Hill (3). In longer runs, hurdles, and the steeplechase, training and motor skill become more important.

Discussion presented in this section is, however, mainly suggestive in nature. The reasoning itself, in the authors' opinion, might be sane. Yet the good agreement of data with this reasoning can be an "optical illusion": it is not at all sure that the results in different sports events are measured along the "same axis," meaning that a "distance" in results of 50 per cent between two contestants, for example, in javelin and 10,000 m. would not necessarily be the "same thing." If A throws 50 m. in javelin and B 75 m., C running 10,000 m. in 45 min. and D in 30 min., it cannot be said with certainly that the relations

A to B and
C to D

are "equal." Difficulties of this type cause any conclusions based on differences in parameters of distribution of results in different sports events, so far, to be considered as preliminary.

General Discussion

The consideration of the multiplicity of determinants is in no way specific to achievement in sports. Quite the same laws are applicable to all human achievements. The widest ranges of achievement are to be expected in the most purely cerebral activities. The necessity of training further widens the range, as, of course, also the number of primary, innate characteristics required as a combination.

The distribution of wealth, undoubtedly, is the expression of a special ability—of the ability to collect and keep high incomes in a competing community. Since the Pareto distribution was discovered, the distribution of other special abilities has also been subjected to study. Attempts have also been made to derive theoretically such a distribution. These attempts have led to a similar result; good theoretical argument can be established in support of the Pareto distribution, though the latter was originally based on purely empirical observations (1). The reasoning has indeed led to the development of a generalized law of inequality, which finds its expression in the type of distribution described.

The same general problem has been discussed by Boissevain.[2] Davis quotes Boissevain:

[2]C. H. Boissevain, cited by Davis (1)—*Metron*, 13:4:49 (1939).

"If a simple physical attribute like eyesight or muscular coordination is graduated according to the classmarks 0-1-2-. . . , -n, the frequency of each class is given by the binomial coefficients ${}_nC_r$. We may assume that the classmark for the ability of an individual to play baseball or billiards is given by the product of the classmarks for each of the separate factors (eyesight and muscular coordination) that are essential for the development of such skill. Adoption of the product rather than the sum for this purpose represents the fact that a man with excellent eyesight but very poor muscular coordination will undoubtedly be inferior as a baseball player to a man with average eyesight and average muscular coordination. In other professions, a man with great energy and very low intelligence may be inferior to a man of average intelligence and energy.

"If the classmark for baseball ability is n_1n_2, when n_1 is the classmark for eyesight and n_2 that for muscular coordination, we can form n classes by dividing the range from O to n^2 in n equal intervals and giving them the classmarks O to n-1. If the number of individuals with the classmark r_1 for eyesight be ${}_nC_{r_1}$, the number of those individuals having the classmark r_2 for muscular co-ordination is ${}_nC_{r_1}$ ${}_nC_{r_2}$ divided by 2^n. By forming the sums of all such products for which r_1r_2 falls between O and n, n and 2n, etc., the number of individuals in each of these classes of baseball ability is found.

"By repeating this process, the distribution can be found that may be expected for skills depending upon more than two factors. The frequencies to be expected for skills depending upon 2, 3 and 4 independent factors were computed, using the binomial coefficients for $n = 15$."

The results of Boissevain's example were transferred into the form of cumulative frequency distributions by the authors. The negative slope of the distribution line decreased with increasing number of factors, right in line with the argument of the present authors in this section.

Suggested New Point System

As described in section "Results" above, results in different sports events can be made comparable, or measured along a common measuring stick, by applying the principle of equal frequencies. Such an equalization has, in fact, been performed in Figure IV. On the basis of this graph, point allocation on an objective basis would be a technical matter only. Indeed, a possible point scale, not much different from that of the IAAF, is shown uppermost in Figure IV. The authors feel, however, that an application of such a scale should be better based on more exact mathematical calculations than those performed so far.

Summary

When the cumulative frequency of the best hundred results of a number of track and field events each year is plotted on a log-log scale, a straight line is generally obtained. Though this distribution is formally similar to the Pareto distribution (which describes the distribution of income), the coefficient b of the regression equations is much larger in the sports, from -16 to $+116$, than in the distribution of income, where it is approximately -1.5. The distribution of athletic ability thus comes nearer to a semilog-relation.

A high value of b means that the difference between the result of the best and the 100th man is small in relation to the total time used, centimeters jumped, etc., and vice versa. The highest values of b were obtained in events

—like 100-meter and 800-meter runs—in which the result is evidently determined to a large extent by relatively few physiological factors, like the speed of muscle contraction, maximum oxygen uptake, or oxygen debt. The lowest values of b were associated with such events in which the contribution of the central nervous system becomes more dominant, either due to the necessity of long-term training—long distance running—or to the intricacy of movements—jumps, throws.

The frequency of each result in an event may be used as a measure of its "value." In this way, results attained in different events may be made comparable on an objective basis.

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A Time and Motion Study of Competitive Backstroke Swimming Turns

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Abstract

A time analysis and motion study of two methods of performing backstroke swimming turns was administered to a selected group of 50 swimmers, ages 18 and over, and an experimental group of 50 swimmers, ages 17 and under. Significant time differences between the experimental method and the universally used method were found for both groups. The majority of the swimmers achieved faster times using the experimental method. Utilizing underwater photography, motion studies determined that seven distinct body movements are eliminated when using the experimental method.

SWIMMING is a human asccomplishment older than recorded history. It is only in the last half century, however, that man has brought to it anything approaching the proficiency of which he is mentally and physically capable (23, 17). One of the most important skills in competition, in addition to speed of propulsion through the water, is that of making a fast and effective turn. It is here that many split seconds are gained or lost.

Purpose of the Study

This study has attempted to determine what type of competitive backstroke swimming turn is faster: 1. The somersault turn followed by the two-arm glide. This is the turn currently used by competitive backstroke swimmers (1,2,3,8,12,15,19,20,21). 2. The somersault turn followed by the one-arm glide. Here the arm which first makes contact with the side of the pool, and is subsequently used for leverage support during the somersault, remains at the side during the push-off and the glide following the turn. The other arm remains extended and does not flex for a sculling motion, however, it rotates at the shoulder joint into a supine position, palm upward.

Review of Related Literature

AQUATICS

After making a comprehensive study and review of the literature in the aquatic field, there was no evidence of experimental research on swimming turns (22). Similarly, no literature was found on the experimental one-arm

glide method of competitive backstroke turning (1,2,3,8,12,15,19,20,21). It was concluded, therefore, that no study nor analysis of this type, involving the timing of the turn interval and the gliding speed that follows, had been undertaken. Studies have been completed, however, on numerous phases of competitive swimming, especially the methods of self-propulsion through the water (1,4,5,6,7,13,18).

INDUSTRIAL ENGINEERING

In reviewing the literature for split-second time-analysis information, it was found that Kimball (11) had stated that stop watch timing had been successfully used in industry to measure and analyze split-second motions of the hands, eyes, and other parts of the body. Also since the turn of the century, industrial engineering has pioneered in the utilization of motion picture sequences in order to analyze and improve upon the split-second movements which are repeated over and over again.

Many of these basic principles of motion economy (10) were applied in developing a new method of performing a backstroke swimming turn. It was felt that the principles of motion economy as stated by Gilbreth (9) apply as equally to the repetition found in swimming turns, as they do to any of the other movements that people are likely to repeat. These principles of motion economy are sometimes called the laws of motion (9).

The purpose of photographing the various motions involved in this new method of performing a backstroke swimming turn was to compare the new and old methods. In this way wasted movements could be detected and could be eliminated in the future. Upon further review of the motion study literature, it was found that this procedure is in conformity with the objectives of motion research propounded by those prominent in this field of study (10, 16, 14).

Procedure

SUBJECTS

With the co-operation of more than 120 coaches and swimmers, it became possible to compile detailed time-study information. This was accomplished by testing and retesting over 100 competitive swimmers. The subjects selected were limited to two groups. One group was made up of 50 college and adult swimmers, ages 18 and over; and a second group was composed of 50 secondary school swimmers, ages 17 and under. Experimental time and distance data was supplemented by interviewing and observing the swimmer and tabulating such factors as age, height, weight, and body build.

INSTRUCTIONS

Instructions (7) were then given concerning the experimental method of performing the somersault backstroke turn followed by a one-arm glide. The experimental turn was demonstrated in the pool, oral directions followed, and visual presentation depicted the motions in the experimental turn. The attention of each swimmer was directed to the following two details of the experimental one-arm glide turn, as illustrated in Figure I. 1. The arm ini-

tially making contact with the side of the pool, and used for leverage support during the somersault, remains at the side in the push-off and the one-arm glide. 2. The trailing arm does not bend to scull. It remains extended, simply turning or rolling over to become the leading arm in the one-arm glide following the turn.

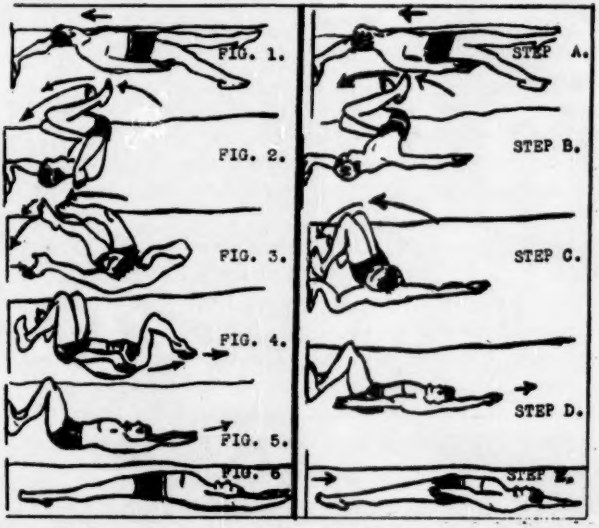


FIGURE I. Visual Instruction on Competitive Backstroke Swimming Turns. The two methods include (left) the standard two-arm glide turn (3) and (right) the experimental one-arm glide turn.

LEVEL OF PERFORMANCE

Time and distance measurements were taken on the swimmers for both methods of turning only after the following two conditions were met: 1. Sufficient instruction and coaching was given so that each individual swimmer demonstrated by actual performance in the pool that he understood fully the mechanics of the two types of turns to be measured. 2. Using a rating scale (7), all swimmers had to have a rating of average or above prior to testing. This was always done with the assistance of at least one other qualified and experienced swimming coach or instructor.

Prior to all time and distance measurements, the swimmers were instructed that they were to start their individual approach to the turn at least ten yards from the turning surface. This made it possible for each swimmer to attain maximum swimming speed for making the turn. Sufficient time intervals of two minutes or more between time trials insured that none of the swimmers became fatigued. The swimmers alternated with each other in performing the backstroke turns.

TESTING SEQUENCE

Swimmers (2) were initially selected and tested on the standard somersault backstroke turn followed by the two-arm glide (3). The majority of the college and adult swimmers were proficient in this established standard method (3); therefore, no additional instruction was necessary. After at least ten days following the initial instructions, time and distance measurements were taken on the experimental one-arm glide method of turning. This allowed for a sufficient period in which to practice the new turning method.

TESTING METHODS

Equipment was devised, and the method of timing the swimmers was developed after many unsatisfactory attempts. The most practical, convenient, and effective method of timing was developed after purchasing two Lyceum stop watches and constructing two red plumb lines and a five-yard measuring line.

When timing the swimmers, the timer consistently placed himself in a position five yards from the turning surface of the pool. The right hand of the timer was nearest to the turning surface, and the left foot was customarily placed on the red five-yard marking line. Directly across the pool a similar five-yard marking line was dropped. The experimenter used a five-yard measuring line in order to accurately drop the red marking lines.

The position of the stop watches in the hands of the timer was such that the index fingers of both hands were used to operate the watch stems.

TIME ANALYSIS

Three time and distance measurements, expressed in tenths per second, were recorded on each turn made by the swimmer. Instructions for timing were as follows: 1. Start both watches simultaneously when the hand of the swimmer first touches the side of the pool. 2. Stop the watch in the right hand when the last contact is made with the wall, by the feet, in the push off. 3. Stop the watch held in the left hand when the swimmer's hands (or hand for the one-arm glide) cross between the red five-yard marking lines. 4. By subtracting the reading on the right hand watch (Turn Interval Time) from the left hand watch (Over-all Time), the (Gliding Time) of five yards is arrived at.

This timing procedure was repeated five times per swimmer for each type of turn. A total of 15 measurements per swimmer for each type of turn and a sum total of 30 measurements for the two types of turns resulted.

MOTION ANALYSIS

A study and analysis of the motions used in both types of competitive backstroke swimming turns was made on February 25, 1956, at the Park View Junior High School, Cranston, R. I. A 16-mm motion picture camera was placed inside a biology laboratory aquarium, with the lens of the camera pressed flush against the glass side of the aquarium. One hundred feet of 16-mm film (30.48M), No. 389 Cine-Kodak, Super-XX High Speed Panchromatic Safety Film, recorded the motions involved in using both types of turns.

From this film the best sequence of motions, in performing the experimental somersault backstroke turn, was selected and enlarged for motion analysis purposes.

Findings

POSITIVE HYPOTHESES TESTED

The hypotheses tested in this study were as follows: 1. That the somersault turn followed by the one-arm glide is faster than the somersault turn followed by the two-arm glide. There were two reasons advanced for this premise. The first being the elimination of two arm motions and the time that it takes to complete said motions. Secondly, the elimination of the water resistance caused by the action of the leverage arm moving from the side of the pool, through the water and then extending beyond the head for the two-arm glide. Also, elimination of the water resistance caused by the movements of the trailing arm. 2. That the glide which follows each of these two types of turns may be slightly faster with a two-arm glide because significant water resistance may be caused by the shoulder of the arm which has not been extended on the one-arm glide. 3. That the backstroke somersault turn followed by the one-arm glide is, overall, the faster maneuver to use in competitive backstroke swimming. This may be true because the gain in time saved on the turn proper, as described in 1. may more than offset the slight delay in gliding which is described in 2.

In order to prove or disprove the positive hypotheses, data was compiled on two groups of swimmers. The first group consisted of a selected group of 50 college and adult swimmers. They were selected because of their competitive backstroke swimming experience. These swimmers had been previously taught the standard two-arm glide method of performing a competitive backstroke swimming turn. On the basis of the data tabulated for 50 college and adult swimmers, the standard and experimental methods of turning are analyzed in Tables 1 to 3 inclusive.

RELIABILITY TIME CHECK

In order to check the reliability of the timing method used in conducting the turn experiments, reliability time checks were made with the co-operation of three swimming coaches. After proper training in using the same method of timing, it was found that these individuals were achieving approximately the same results. The coefficient of correlation .999 indicated a near perfect correlation between the individual times obtained by the author and the coaches doing the checking.

STATISTICAL SIGNIFICANCE—CONTROL GROUP

Table 1 presents the results of the tests for the turn interval. The mean score for the standard turn is 1.376 seconds as compared with 1.16 seconds for the experimental method. The difference of .216 seconds in favor of the experimental method yields a critical ratio of 7.5. The difference can be interpreted to be statistically significant at the 1 per cent level.

TABLE 1

Comparison of the Turn-Interval Time Measurements for 50 College and Adult Swimmers—Using the Standard Two-Arm Glide Method and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	1.376	.0322	.288	.216	.0288	7.5
Experimental One-Arm Glide Method	50	1.16	.02503	.177			

TABLE 2

Comparison of the Five-Yard Glide Time Measurements for 50 College and Adult Swimmers—Using the Standard Two-Arm Glide Method and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	1.018	.0234	.166	.042	.0226	1.41
Experimental One-Arm Glide Method	50	.976	.022	.155			

In Table 2, the five-yard glide times for the experimental method show a mean of .976 second as compared to 1.018 seconds for the standard method. The small difference of .042 second is again in favor of the experimental one-arm glide method.

The critical ratio 1.41 is not statistically significant. Such a difference is due to chance 16 out of 100 times.

TABLE 3

Comparison of the Turn Interval and Five-Yard Glide Time Measurements for 50 College and Adult Swimmers—Using the Standard Two-Arm Glide and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	2.394	.042	.295	.258	.037	6.97
Experimental One-Arm Glide Method	50	2.136	.033	.234			

In Table 3, a comparison of the two means for the turn interval and the five-yard glide reveals a wide difference between the experimental and standard methods of turning. The difference .258 second shows a critical ratio of 6.97. This difference can be interpreted to be statistically significant at the 1 per cent level.

STATISTICAL SIGNIFICANCE—EXPERIMENTAL GROUP

On the basis of the data tabulated for 50 swimmers, ages 17 and under, the standard and experimental methods are analyzed in Tables 4 to 6, inclusive.

TABLE 4

Comparison of the Turn Interval Time Measurements for 50 Secondary School Age Swimmers—Using the Standard Two-Arm Glide Method and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	1.480	.032	.226	.246	.0287	8.57
Experimental One-Arm Glide Method	50	1.234	.025	.178			

Table 4 presents the results of the tests for the turn interval. The mean score for the standard turn is 1.480 seconds as compared with 1.234 seconds for the experimental method. The difference of .246 second in favor of the experimental method yields a critical ratio of 8.57. The difference can be interpreted to be statistically significant at the 1 per cent level.

TABLE 5

Comparison of the Five-Yard Glide Time Measurements for 50 Secondary School Age Swimmers—Using the Standard Two-Arm Glide Method and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	1.262	.040	.283	.114	.0373	3.06
Experimental One-Arm Glide Method	50	1.148	.034	.243			

With reference to Table 5, the five-yard glide times for the experimental method show a mean of 1.148 seconds as compared to 1.262 seconds for the standard method. The difference of .114 second is in favor of the experimental one-arm glide method. The critical ratio of 3.06 is statistically significant at the 1 per cent level.

In Table 6, a comparison of the two means for the turn interval and the five-yard glide reveals a wide difference between the experimental and standard methods of turning. The difference .362 second shows a critical ratio of 6.47. This difference can be interpreted to be statistically significant at the 1 per cent level.

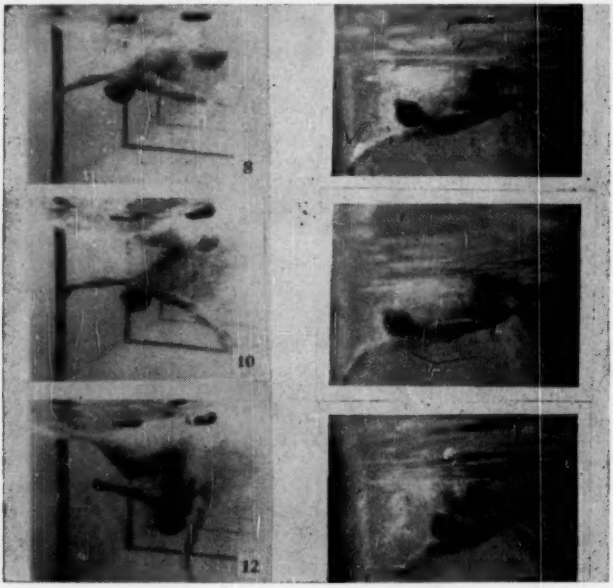
TABLE 6

Comparison of the Turn Interval and Five-Yard Glide Time Measurements for 50 Secondary School Age Swimmers—Using the Standard Two-Arm Glide Method and the Experimental One-Arm Glide Method

Method Used	N	Mean	S.E. Mean	S.D.	M_1–M_2 Diff.	S.E. Diff.	C.R.
Standard Two-Arm Glide Method	50	2.744	.060	.427	.362	.0559	6.47
Experimental One-Arm Glide Method	50	2.382	.050	.360			

MOTION ANALYSIS

Through the medium of underwater photography, it is possible to present Figure II. In the right-hand column is found a picture sequence of the motions involved in the new experimental method of performing a backstroke swimming turn. The old or standard method of competitive backstroke turning has been reproduced from the textbook written by Kiphuth (12).



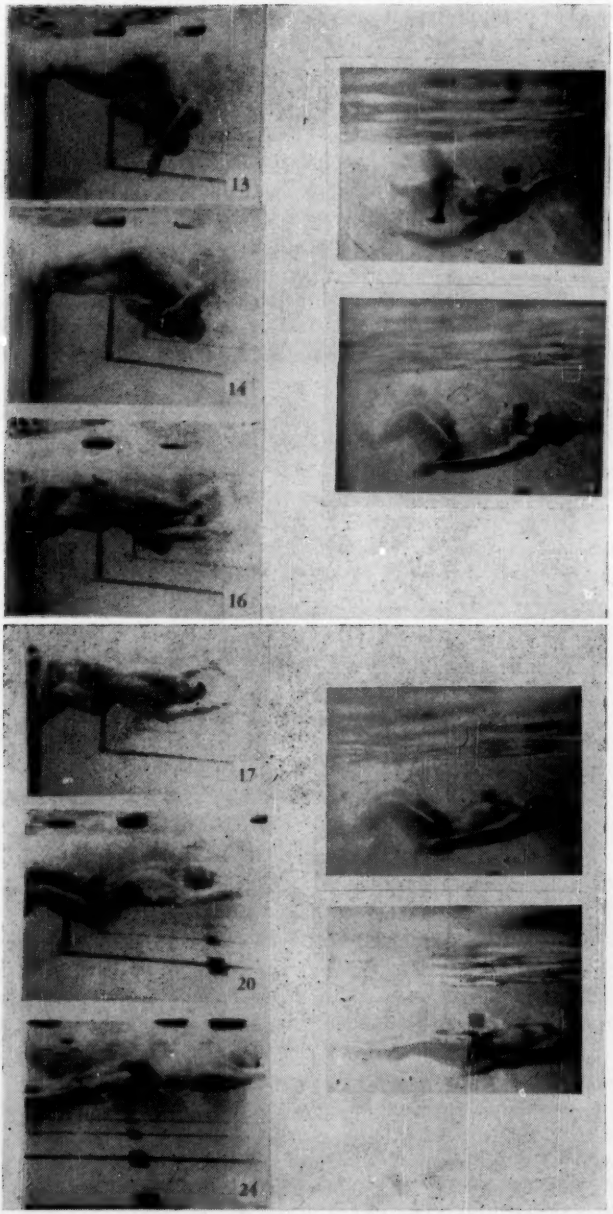


FIGURE II. Comparative Motion Analysis of Two Methods of Performing a Competitive Backstroke Swimming Turn—Standard method (left) and experimental method (right).

As illustrated in Figure II, the experimental turn can be performed starting with the hand of the leverage arm being placed at approximately 2 feet below the surface with the fingers pointed down. As the momentum of the swimmer carries him into the wall, he not only flexes the arm which is in contact with the wall, but he also has flexed his legs into a tightly tucked position simulating a backward somersault. To be specific, the swimmer executes a one-quarter backward somersault and a 180° semi-horizontal spin into the wall.

The wall contact, which is maintained by the flexing leverage arm, allows the swimmer's feet to hit the wall with legs flexed in the maximum power-push position. At the instant that the feet hit, therefore, the push-off is executed—followed, of course, by the one-arm glide.

Note that both of the arm movements found in the standard method of turning have been eliminated in the experimental method. The leverage or wall-contacting arm remains at the side, and the other arm remains extended, thus becoming the leading arm in the one-arm glide following the turn.

As in all backstroke turning, the hand of the arm of the swimmer which first makes contact with the wall is merely a matter of chance. Backstroke swimmers are expected to become equally adept at using either arm as their leverage arm.

The underwater motion pictures show clearly that the following motions are eliminated when using the experimental turn as compared to the standard turn: 1. Head and shoulders dropping backwards. 2. Back arching and bending backwards. 3. Entire upper trunk moving through a back somersault arc of 180°. 4. Right trailing arm of the swimmer flexing, sculling, and then extending again prior to the glide. 5. Left arm of the swimmer moving from the wall, through the water, and extending over the head for the glide. 6. Legs flexing beyond the maximum power-push position as the feet hit the wall. 7. The quarter-twist movement of the entire body.

Summary of Results

The faster and more effective method of performing a competitive backstroke swimming turn is the experimental motion-saving method followed by the one-arm glide. These conclusions are not only based on time and distance data but also upon comparative motion analysis, utilizing underwater photography.

The mean average times saved when using the experimental one-arm method of backstroke turning and gliding as compared to the standard two-arm method are: 1. For the selected group of 50 college and adult competitive swimmers, ages 18 and over—¼ second faster per turn per swimmer. 2. For the experimental group of 50 secondary school age swimmers, ages 17 and under—⅓ second faster per turn per swimmer.

Contrary to the original positive hypotheses, there was no time evidence to indicate that the one-arm glide, as used in the experimental turn, is slower

than the two-arm glide. The results indicated that the one-arm glide of five yards immediately following the experimental turn is usually faster than the two-arm glide following the standard turn for the secondary school age swimmers (see Table 4). The times compiled for the 50 college and adult swimmers, when using the one-arm glide for five yards, were statistically insignificant having a low critical ratio of 1.41 (see Table 2).

Using motion pictures of both methods of turning, the photographic results of this illustrate actual examples of needless activity, inefficiency, delays, a lack of motion economy, and hesitation as affecting the continuity of body movement. Comparative photographic analysis determined that seven distinct body movements are eliminated when using the experimental method.

The experimental turn movements require less water depth, thus permitting the swimmer to execute them with greater safety in the shallow end of a swimming pool.

Through time and motion study and analysis, it is possible to determine the type of turn which is the fastest and most effective for each individual competitive swimmer to use. This improves teaching and coaching technique.

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General Factors or Components of Character as Related to Physical Education

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Abstract

Three factor analyses were published. The first was a factor analysis made of 31 students who were physical education majors at George Williams College. In this factor analysis, the students were carefully coached as to the meaning of each of the variables. Each student also was rated as to how well he knew each other student. He was then given training on the rating of each student whom he felt that he knew very well and whom he did not particularly like or particularly dislike. He rated these students, and each student rated himself. The rating used was the average rating by all of the students, but the rating was checked by the rating by the student himself. It should be stressed, however, that the rating used was the total rating of the students.

The second rating was by Dr. Edward Webb and was published in "Character and Intelligence" in the *British Journal of Psychology, Monograph Supplement No. 1* in 1915. Only the raw ratings were published, but these were the average of the ratings of all. The factor analysis was done by the senior author.

The third rating was done on Duluth, Minnesota, elementary school children. The pupils were coached as to how the ratings should be interpreted and were trained in the meaning of each rating. The ratings were factored by the junior author.

IF A PROGRAM of character education is to be effective, whether conducted in connection with physical education activities or in connection with other programs, the task should be approached with as much accurate knowledge of the nature of each aspect of the process as possible. If all of the character qualities to be emphasized were specific to a single situation only, the task of character education would be well-nigh hopeless. The fact that one trait, such as honesty, may cover a large number of different kinds of meanings does not mean that it is poor practice to use general terms, *if* the general terms are well defined and the *general principles* behind each are understood. While generalities may not be completely effective, carefully stated *general* definitions of terms may be much more useful than carelessly stated specific terms. Hence it would seem worthwhile to attempt to isolate the "general factors" or "components" of which the more specific "traits" are composed, to attempt to define and to understand them, and to outline briefly how they may be used in the process of character education.

Method

To accomplish this, Thurstone's Centroid Method of factor analysis[1] was used throughout the three studies reported in this study.

In general, there are two basic methods of obtaining a meaningful factor matrix, or set of "factor loadings." Both start with what is called an "unrotated factor matrix." One method rotates to obtain a psychologically meaningful set of "rotated factor loadings," often obtaining "oblique factors"—that is, factors which are not necessarily uncorrelated with each other and which are usually not independent factors. The factors may be—and often are—overlapping in meaning. For example, if two of the factors that are basic to track and field athletic activities are *force* (or muscular strength) and *potential contraction speed of muscle*, the combination of the two will be *power*. (Power equals the time rate of work, or $\frac{Fd}{t}$. Since $\frac{d}{t} = V$, $P = FV$.)

Here, if we factor events of pure force (such as strength tests) and measurements of pure contraction speed (velocity), and also a number of different kinds of track and field activities, the track and field variables will all be oblique, both to the strength axis and to the contraction speed axis, and will fall between the two—for they are compounded of the combination of the two. Hence, if this method of oblique rotation is used (for example, if an axis is run through the track and field events), it may be impossible to extract pure, uncorrelated, completely "general" factors.

The other method of rotation is to rotate orthogonally (all axes at right angles to each other), or so that all of the factors are uncorrelated, each with the other. This may be more difficult, and will often depend on the subjective analysis of such traits as character qualities, and depend upon logical analyses rather than upon the mechanical clustering of traits on the plot—especially if the (character) traits are compounds of several factors, as they usually are, and if some of them are negatively correlated with a given factor.

In each of the studies reported here, the second method of rotation (orthogonal rotation) has been used. The authors feel that, while other research workers might have obtained somewhat different results, due to different observations and processes of reasoning, the results herein reported seem quite defensible, and usable for purposes of character education.

Procedure

Three studies are herein reported. The data of the first study (conducted by the senior author) were obtained from 31 junior and senior physical education students of George Williams College in Chicago. These data were obtained in 1933 and a tentative publication of the results was made,[2] but was

[1] L. L. Thurstone, *Multiple-Factor Analysis.* Chicago: University of Chicago Press, 1947, Chapter VIII.

[2] C. H. McCloy, "A factor Analysis of Personality Traits to Underline Character Education," *Journal of Educational Psychology,* **27**: 5 May, 1936.

limited by the fact that, at that time, only three factors could be rotated successfully. Since that time, methods of rotating an unlimited number of factors have been developed, and hence this study is again reported here with the full number of factors isolated, namely eight factors.

In conducting this first study, all traits were carefully defined, the definitions mimeographed and given to all of the students. These definitions were carefully studied until they were understood. Each student was then asked to study a copy of a list of names of all the students concerned, and first to check the names of each of those whom he felt that he knew well enough to rate accurately. In the second column, he was asked to check the names of students whom he particularly liked, and these were crossed off his list to avoid the "halo" effect. In the third column, he was asked to check the names of those whom he rather disliked, and those names were also crossed off that rater's list. Each student then was given the names of five students whom he felt that he knew very well, did not particularly like nor particularly dislike, and he was asked to rate those. Each person also rated himself.

A five-category rating was explained to the students, five indicating that the individual possessed that quality in very high degree, three that the individual possessed it to an average degree, and one that he possessed it to a minimum degree. It was noticed that the traits of one person as rated by all five raters tended to cluster around one number and it was rather unusual not to have the individual's self-rating be rather close to the median of the ratings by the other students. It will be noted that a number of traits which were not directly related to character were also introduced, as well as two general ones—"character" and "personality." These traits were introduced purely because of the curiosity of the author, who wished to see where they would stand in such an analysis.

The second study (factored by the senior author) was that published originally by Webb.[3] Part of Webb's study was conducted on 194 college men. Altogether ten prefects were used in rating, each student being rated by two prefects. These prefects studied the men rated for several months, until they were thoroughly well acquainted with them. The study was not particularly related to physical education. The traits were all carefully defined and the definitions given to the raters to study for some time before they proceeded to the task of observing and studying these individuals. Nine factors were isolated and identified.

The third study, done by the junior author (Dr. Hepp), was carried out on data collected in some of the sixth grades of the public schools of Duluth, Minnesota, through the co-operation of Miss Florence Owens, supervisor of physical education. There were 211 subjects, all male. The 55 variables were selected partly from those used in the first two studies and partly from a list developed by a group of 315 elementary school teachers in Duluth, and others

[3] Edward Webb, "Character and Intelligence," *British Journal of Psychology, Monograph Supplement No. 1*, 1915.

TABLE 1

George Williams College Study

Traits	Individual Social or Indiv. Good Citizenship	Self-Mastery	Group Social or Group Good Citizenship	Positive Attitudes	Leadership	Individuality	Individual Self-Sufficiency	Positive Action Tendencies	Communalities
1 Adaptive	.38	.32	.03	.01	.38	.29	.47	.26	.76
2 Aggressiveness	.01	.17	—.27	.41	.41	.19	.06	.59	.83
3 Alertness	—.12	.30	.01	.34	.23	.37	.40	.15	.58
4 Athletic ability	.02	—.03	—.23	—.05	.16	.75	.42	.05	.83
5 Character	.35	.22	.61	—.15	.41	.24	.14	.15	.83
6 Co-operation	.34	.16	.52	—.23	.32	—.08	.31	.12	.69
7 Can discipline others	.34	.01	.06	.24	.38	—.09	.19	.61	.75
8 Conviction	.24	.32	—.07	.21	.06	.11	.14	.47	.46
9 Cool-headed	.33	.50	—.004	.11	.11	.27	.36	.07	.58
10 Decisive	.01	.37	.07	.002	.23	.20	.16	.38	.40
11 Egotistical	—.09	.11	—.13	.15	.06	.26	—.23	.11	.20
12 Enthusiasm	.16	.23	.38	.35	.41	—.10	.14	.13	.56
13 Energy	—.08	—.26	.25	.54	—.11	.26	.04	.60	.88
14 Fairness	—.12	—.06	.67	.10	.48	.07	.31	.06	.81
15 Fight	.18	.11	.26	.21	.24	.10	.29	.09	.32
16 Good appearance	.29	—.08	.14	.30	.09	.60	.12	—.002	.59
17 Good follower	.21	—.01	.75	.05	.26	.10	.12	—.03	.71
18 Hard worker	.08	.36	.43	—.001	—.11	.43	.29	.37	.74
19 Health	.37	.14	.36	.23	—.40	.47	.30	—.03	.81
20 Initiative	.52	.23	—.09	.38	.15	.21	—.19	.36	.70
21 Integrity	.62	.24	.65	.12	.02	.15	.02	—.005	.91
22 Leadership	.42	.50	.08	—.14	.48	—.03	.30	.37	.91
23 Loyalty	.0003	.57	.57	.06	.13	.09	.42	—.01	.85
24 Magnanimity	.009	.22	.38	.24	.35	.08	.39	.14	.55
25 Modesty	.004	.05	.24	—.23	.17	—.16	.55	—.35	.59
26 Moral courage	.28	.55	.09	.14	—.06	—.01	.66	.10	.87
27 Perseverance	—.04	.27	.43	.08	.08	.25	.51	.27	.67
28 Personality	.69	.18	.21	—.003	.31	.32	.31	—.09	.86
29 Physical courage	.42	.22	.40	.04	—.001	.23	.43	—.009	.63
30 Poise	.53	.06	—.21	.04	.38	.41	.26	.15	.74
31 Popularity	.15	.37	.03	—.03	.48	.51	.22	.14	.72
32 Resourcefulness	.37	.17	—.13	.09	.10	.23	—.04	.59	.61
33 Respect for law	.28	—.007	.48	.0009	.09	.01	.38	.50	.71
34 Resp. for rights of others	.35	.07	.62	.09	.29	—.06	.44	.16	.83
35 Self-confidence	.25	.26	—.11	.59	.06	.001	—.02	.43	.68
36 Self-control	.49	.25	—.04	.07	.35	.24	.27	—.03	.55
37 Sociability	.25	.56	.19	.17	.24	.51	.24	—.01	.82
38 Self-sacrifice	.32	.42	.36	.36	.23	.12	—.03	.04	.61
39 Self-denial	.17	.66	.49	—.06	.03	.04	—.02	.28	.80
40 Sportsmanship	.66	.07	.28	.13	.10	.23	.49	.04	.84
41 Thoroughness	.48	.34	.24	.21	.06	.16	.34	.38	.74
42 Trustworthiness	.61	.13	.45	.10	.09	.07	.41	.16	.82
43 Vitality	.45	.30	.15	.41	—.04	.14	.50	.04	.76

TABLE 2
Webb Study

Traits	Group Social or Group Good Citizenship	Anti-Social Dominance	Positive Action Tendencies	Buoyant Individuality	Individual Social or Individual Good Citizenship	Sociability	Self-Mastery	Leadership	Good Emotional Adjustment	Communalities
1 Tendency to be cheerful	.30	—.10	.27	.38	—.21	.20	.32	.04	.33	.61
3 Liability to extreme depression	—.13	.02	—.16	.33	.03	—.08	—.42	—.14	—.53	.64
4 Readiness to become angry	.04	.80	.06	—.02	—.16	—.01	—.14	—.03	—.31	.80
5 Readiness to recover from anger	.36	—.55	.07	.14	.02	—.04	.44	.09	.19	.69
9 Desire to excell in performance in which lies his chief interest	.20	.28	.30	.001	.48	.16	.41	.47	—.18	.88
10 Desire to impose will on others	.08	.85	.02	.17	.005	.02	—.02	.12	.007	.77
11 Eagerness for admiration	.04	.75	—.14	.33	—.20	.16	.26	—.09	—.33	.95
12 Belief in own powers	—.03	.69	.35	.24	.15	—.02	.17	.009	—.04	.71
13 Esteem of self as a whole	—.04	.76	.19	.28	.04	—.07	.03	.18	—.02	.74
14 Offensive manifestation of self-esteem	—.08	.83	.07	—.007	—.11	.05	.04	.06	—.12	.73
15 Fondness for large social gatherings	.61	.31	.31	.22	—.49	.02	—.16	.26	.08	.94
16 Fondness for small circle of friends	—.05	—.13	.31	—.09	.46	—.06	—.05	.31	.09	.44
17 Impulsive kindness	.29	—.31	—.10	.56	.03	—.004	—.07	.22	—.02	.56
18 Kindness on principle	.27	—.60	.08	.38	.44	.12	.02	.29	.03	.88
19 Degree of corporate spirit	.61	—.10	.10	.09	.03	.28	.05	.39	.06	.64
20 Trustworthiness	.04	—.59	.07	.06	.56	.25	.15	.22	—.0003	.81
21 Conscientiousness	—.15	—.62	.08	.02	.56	.17	.02	.33	—.04	.87
23 Readiness to accept sentiments of his associates	—.0001	—.64	—.27	.06	—.18	—.05	.30	—.03	—.28	.69
24 Desire to be liked by his associates	.64	.03	—.16	.31	.10	.21	.26	.13	—.27	.74
25 Wideness of influence	.57	—.05	.23	.04	.48	.43	.05	—.03	.27	.88
26 Intensity of his influence on his social intimates	.17	—.07	.37	.32	.43	.36	—.01	.16	.22	.65
27 Tact in getting on with people	.53	—.43	.10	.11	.10	.18	—.04	—.23	—.01	.58
28 Mental work on studies	—.07	—.07	.32	.07	.65	—.06	.36	.01	—.27	.75
29 Mental work on pleasures	.30	.18	—.06	—.02	—.28	.53	.10	.31	.19	.62
31 Bodily activity on pleasures	.37	.23	—.01	.03	—.30	.47	—.006	.40	.16	.68
33 Tendency not to abandon tasks	.04	—.13	.37	.07	.43	.16	.19	—.06	.40	.57
35 Quickness of apprehension	.10	—.02	.52	.39	.12	.52	—.02	—.03	.01	.73
36 Profoundness of apprehension	—.0004	—.23	.60	.14	.43	.38	.02	.04	—.06	.77
38 Originality of ideas	.11	—.05	.64	.30	.18	.39	.06	.03	.01	.71
40 Physique	.16	.04	.86	.18	.05	.18	.21	.02	—.05	.87
44 Athletics	—.05	.06	.58	—.0001	.28	—.04	.38	.006	—.24	.62

Omitted numbers were not pertinent and were not factored.

TABLE 3

Duluth Study

Traits	Conscientiousness	Positive Action Tendencies	Good Social or Group Good Citizenship	Individual Social or Individual Good Citizenship	Passive Group Responsiveness	Anti-social Domination	Buoyant Individuality	Egotistical Self Sufficiency	Communalities
1 Accuracy	.54	.42	.25	.26	—.008	.28	.11	.17	.72
2 Adaptability	.36	.36	.39	.30	.25	.22	.13	.02	.63
3 Aggressiveness	.05	.49	.07	.07	.03	.30	.25	.37	.54
4 Becomes angry easily	—.07	—.02	—.18	.16	.08	.32	.07	.15	.20
5 Attentiveness	.46	.32	.22	.50	.11	.17	.05	.24	.71
6 Cheerfulness	.25	.05	.49	—.25	.56	.17	.43	.09	.90
7 Concentration	.50	.41	.36	.32	—.05	.14	.12	.20	.72
8 Consideration for others	.24	.002	.58	.49	.25	—.03	.23	.09	.76
9 Co-operation	.25	.40	.47	.40	.26	—.13	—.05	.10	.70
10 Courage	.07	.55	.37	.04	.09	—.005	.15	.13	.49
11 Courtesy	.39	—.02	.53	.30	.42	—.16	—.07	.34	.85
12 Cruelty	—.34	—.20	.05	.10	—.27	.58	.06	—.21	.62
13 Decisiveness	.27	.38	.19	.34	.02	.20	.13	.33	.54
14 Dependability	.31	.21	.44	.78	.04	.01	—.11	.17	.997
15 Desire to excel	.18	.36	.08	.36	.08	.30	.09	.31	.50
16 Desire to do the opposite	—.20	—.09	—.44	.08	—.19	.09	.34	.09	.42
17 Desire to impose will on others	—.30	—.04	—.13	—.23	—.29	.71	—.07	.24	.80
18 Diligence	.56	.36	.25	.39	.15	.29	—.12	.17	.80
19 Eagerness for admiration	—.15	.15	—.08	—.13	.06	.07	.04	.49	.45
20 Enthusiasm	—.07	.55	.33	.17	.24	.25	.16	.20	.64
21 Enviousness	—.32	—.33	—.22	.11	—.20	.30	.30	.20	.53
22 Generosity	—.16	.28	.34	.11	.58	.26	.34	.12	.77
23 Good fellowship	.10	—.008	.55	.36	.55	.15	.28	.06	.85
24 Good citizenship	.28	—.03	.69	.41	.29	.13	.17	.10	.86
25 Group mindedness	.05	.43	.38	.05	.44	.003	.18	.01	.56
26 Health	—.05	.23	.51	.06	.08	.12	.06	.003	.34
27 Honesty	.02	—.04	.65	.52	.27	.11	—.18	.10	.83
28 Individuality	.05	.43	.35	.01	.09	.08	.41	.35	.61
30 Initiative	.003	.86	.05	.45	—.04	.13	.05	.18	1.00
31 Integrity	.37	.02	.47	.48	.33	.01	.04	.16	.73
32 Judgment	.55	.34	.37	.26	.06	.32	.13	.07	.76
33 Leadership	.16	.61	.35	.11	.05	.23	.24	.10	.66
34 Loyalty	.10	.19	.73	.36	.19	.08	.10	.002	.77
35 Modesty	.31	—.09	.22	.54	.21	—.20	.27	—.21	.65
36 Neatness	.37	.05	.34	.14	.17	.28	.11	.14	.42
37 Openmindedness	.29	.21	.27	.40	.52	.06	.19	.11	.68
38 Perseverance	.55	.23	—.07	.38	.24	.34	.17	.04	.71
40 Popularity	.12	.36	.63	.20	.15	.16	.23	.04	.68
41 Respect for rules and laws	.34	—.10	.52	.68	.06	.16	.36	—.10	1.02
42 Resourcefulness	.38	.60	.18	.12	.17	.23	.36	.15	.79
43 Self-confidence	—.008	.69	—.01	.07	.04	.15	.30	.22	.65
44 Self-control	.49	—.18	.47	.51	—.02	—.12	.32	.09	.88
45 Self-sufficient	.51	.34	.33	.04	—.07	.15	.31	.16	.64
46 Self-esteem	—.02	.17	—.07	.15	.03	.01	.28	.57	.46
47 Self-reliance	.36	.44	.27	.43	.07	.09	.26	.03	.66
48 Sense of humor	—.13	.49	.12	.15	.34	.08	.49	—.06	.66
49 Sociability	—.01	.46	.27	.18	.40	.01	.44	.07	68
50 Suggestibility	.21	.23	.26	—.09	.09	.30	.11	.08	.29
51 Tendency to defer action	—.10	—.30	—.11	.22	—.22	.05	—.17	.06	.24
52 Tendency to positive action	.27	.50	.17	.19	.13	.32	.35	.10	.64
53 Thoroughness	.63	.32	—.16	.40	.11	.23	.18	.10	.78
54 Trustworthiness	.33	—.02	.46	.59	.32	—.10	.11	.07	.80
55 Willingness	.44	.25	.29	.42	.14	—.23	.19	.12	.65

TABLE 4

A List of Factors from Which to Select Character Objectives[1]

1. **"Individual-social"[2] or individual good citizenship (G) (W) (D)**
   Integrity, initiative, trustworthiness, thoroughness, *conscientousness,* poise, *ability to exert a wide influence on others, ability to work hard in one's studies,* dependability, and honesty. R = .86
2. **"Group-social" or group good fellowship (G) (W) (D)**
   Ability to be a good follower, fairness, integrity, respect for the rights of others, loyalty, perseverance, co-operation, *desire to be liked by others,* and, usually, *fondness for large social gatherings.* R = .90
3. **Self-mastery (G) (W)**
   Self-denial, moral courage, sociability, cool-headedness, *ability to recover readily from anger, striving to excel in the field of one's chief interest,* and frequently better than average *athletic ability.* R = .84
4. **Individual self-sufficiency (G)**
   Moral courage, modesty, good sportsmanship, resourcefulness, and perseverance. R = .75
5. **Good adjustment (W)**
   Cheerfulness, persistence, active engaging in social pleasures, lack of tendency to become angry easily or to crave admiration unduly or to give way to fits of depression. R = .51
6. **Individuality, "standing out from the crowd" (G)**
   Athletic ability, a good appearance, popularity, sociability, good health, poise, and *tendency to work hard.* R = .80
7. **Sociability (W)**
   Tendency to work hard at pleasures, quickness of apprehension, exertion of wide influence on others, originality of ideas, and ability to influence one's intimates. R = .68
8. **Conscientiousness (D)**
   Thoroughness, perseverance, accuracy, diligence, *self-sufficiency,* good judgment, attentiveness, and ability to concentrate on one's tasks. R = .67
9. **Buoyant individuality (W) (D)**
   Impulsive kindness, cheerfulness, quickness of apprehension, kindness on principle, and usually a good sense of humor. R = .66
10. **Positive-action tendencies (G) (W) (D)**
    Energy, aggressiveness, adaptability, conviction, *resourcefulness,* initiative, *ability to discipline others,* and usually *originality of ideas.* R=.90
11. **Positive attitudes-energy (G)**
    Self-confidence, energy, enthusiasm, vitality, and alertness. R = .69
12. **Leadership (G) (W)**
    Fairness, aggressiveness, popularity, enthusiasm, resourcefulness, *desire to excel in the activities of one's interest, co-operation,* and *conscientiousness.* R=.79
13. **Egotistical self-sufficiency (D)**
    Eagerness for admiration, self-esteem. R = .56
14. **Passive Group Responsiveness (D)**
    Cheerfulness, generosity, good fellowship, group-mindedness, open-mindedness. R = .69
15. **Anti-social dominance (W) (D)**
    Readiness to become angry, desire to impose will on others, eagerness for admiration, belief in own powers, esteem of self as a whole, offensive manifestation of self-esteem. R = .95

[1]In this list italicized traits are those which have been found to measure the factor most satisfactorily. These traits seem to sum up most of the others (statistically speaking). The numbers at the end (R=.86, for example) are the multiple correlations between the italicized traits and the factors. (G), (W), and (D) denote the George Williams, Webb, and Duluth studies respectively.

[2]"Social" as the opposite of "anti-social."

were added by the authors of the present study. All ratings were made by the classroom teachers. The rather high communalities would indicate a degree of consistency, at least, in the ratings of the teachers, though the reliabilities and objectivities are not known.

Results

The three studies will be reported in turn, the identified factors and variables (traits) rated being given in the three tables.

The George Williams College Study. In this study, eight factors were isolated and identified. The rotated factor matrix is given in Table 1. All factor loadings as large as .4000 or over were carefully studied and may be taken to represent the major variables defining the meanings of the factors.

The Webb Study. In this study, nine meaningful factors were isolated and identified. The rotated factor matrix is given in Table 2. Again, factor loadings of .4000 were taken to represent the nature of the factor.

The Duluth Study. In this study, eight meaningful factors were isolated and identified and the rotated factor matrix is given in Table 3.

A total of 15 factors were identified in the three studies. Only three of these were common to all three studies, and four were common to two of the studies. Eight factors were found in one study only. The reasons for this can readily be understood by noting that the variables were frequently quite different in the three studies. These factors will now be listed without regard to the study in which each first appears, and discussed one by one.

The first 12 of these factors will be ones which seem to the authors to be constructive and factors to be cultivated. The last three discussed are passive or somewhat anti-social, and are not to be cultivated; rather the opposites are to be cultivated. Some of these opposites (traits) will be heavily weighted *negatively*. In view of the fact that the factors of the three studies are labeled consistently, it will be assumed that the reader can readily separate them by noting the factor loadings in each study. In each of the three factor matrices, the factor loadings of .4000 or over are italicized. In a very few cases in which there are few factor loadings with great weights, loadings slightly below .4000 are italicized.

Discussion

From these results, it would seem to be implied that a large number of character traits or qualities may be reduced to 15 important or fundamental components, which sum up a large number of specific elements. The last three of these seem to be negative and in general anti-social, and the authors would suggest that they not be used for character ratings, except for specific research projects. The other 12 components may very well be used for rating accurately a number of properly combined traits, assuming, of course, that the individuals are well known to the raters and that enough raters are used to validate the results to within a reasonable degree of accuracy. We should therefore like to propose the basis of a tentative procedure for character education as related to the various fields of education.

1. In most situations, these general factors are obscured or camouflaged by a mass of specific detail. It should be the endeavor of the character educator to bring these common factors to light, and, as it were, strip off the camouflage of specifics, and, by the use of what Thorndike has termed the "principle of partial activity" focussed upon these prepotent elements, sensitize the individual to these general factors and cause him to recognize these fundamentals readily in all specific situations to which each is pertinent.

2. It should be recognized that there are different varieties of transfer processes. In many situations within one area of experience, common elements almost thrust themselves upon one's notice, as in the case of recognizing the similarity of principles of teamwork in basketball and in a school project of clearing a field for football practice. Such situations are "real" to the child, and are concrete and quite objective. They provide a good place for building fundamental concepts, emotionalizing them, and attaching verbal symbols to both the concepts and the feelings about them. Other situations which have fewer of the common elements apparent, and are better concealed by specifics, must be more carefully attacked by generalizing the principles so that their relationships are clearly seen. Situations in which the only common elements are principles and verbal symbols (such as teamwork in baseball and teamwork in government and politics) should be attacked by leading the pupils first to generalize the principles and then to intellectualize those principles in such a way as to project them into areas of behavior as yet unmet in experience, in order that they may have general rules of behavior based upon intelligently analyzed concrete experiences which have involved these fundamental factors of character.

Stated in another way, the process of generalization is simply carried one step further than usual. In addition to bracketing together specific trait actions having obvious common elements and labeling the result with a generalized trait name, the *groups* of traits which are based upon more general principles are bracketed together and appropriately labeled with a usable and easily understood verbal symbol. The educator should endeavor to cause the pupil to progress from the specific to the trait, and from the trait to the common component of which groups of traits of each type are composed, and to attach significance and emotional drive to these principles of action.

3. It should then be the privilege of the instructor to take advantage of various situations as they arise in his instructional periods to point out constantly these common components and to strengthen and guide this intellectualizing process until the application becomes semiautomatic.[4]

4. Finally, it is suggested that the process of rating behavior in an educational project, particularly from the aspect of behavior qualities which the instructor desires to inculcate and strengthen, may be much simplified by

[4] For more detail on this character education process, see C. H. McCloy, *Philosophical Bases for Physical Education.* New York: Appleton-Century-Crofts, Inc., 1940, Chapter 13.

refraining from rating a great mass of detail and rating instead the individual's status in these fundamental factors.[5]

APPENDIX

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[5] For further suggestions on rating and rating devices in connection with character education related to physical education, see C. H. McCloy and N. D. Young. *Tests and Measurements in Health and Physical Education*. New York: Appleton-Century-Crofts, Inc., 1954, pp. 277-285.

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Measurements of Pulmonary Function in United States Olympic Free Style Wrestlers [1]

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Abstract

Actual measurements of pulmonary function in members of the United States Olympic Free Style Wrestling Team were compared with the figures predicted for these measurements by standard formulae. In general, the actual measurements tended to exceed the predicted figures, but the differences were not statistically significant. Further research is needed to determine whether timed vital capacity is a valuable criterion in distinguishing athletes from non-athletes.

IN THE FALL of 1956, the entire United States Olympic team was assembled in Los Angeles, preparatory to embarking for Australia. During that time the splendid co-operation of the free style wrestlers, of John Drummond, Team Manager, and Briggs Hunt, wrestling coach at the University of California at Los Angeles, enabled the writers to obtain some measurements of pulmonary function in these athletes. The purpose of this paper is to report the measurements which were taken during that investigation and to determine whether they differ significantly from previously determined standards for normal young men.

Review of the Literature

The quantity of published material concerned with the study of respiratory function is enormous, ranging from the theoretical concepts advanced by Gray (10) to the clinical interpretations suggested by McCann (14). The present review contains only references selected for their special relevance to the problem of investigating the pulmonary functions of athletes.

The normal respiratory rate of adult males in the standing position has been given as 22 breaths per minute (24), although it has been reported that Hornicke recorded a respiratory frequency of 18 to 20 breaths per minute in 200 untrained men, versus only 6 to 8 in athletes (11). He concluded that trained men breathe more economically than untrained men, which he

[1] Sponsored by William W. W. Pritchard, D. O., co-ordinator of research and consultant in the Department of Physical Medicine and Rehabilitation, Los Angeles County Osteopathic Hospital. The writers are indebted to Hurley L. Motley, M. D., Cardio-Respiratory Laboratory, the University of Southern California School of Medicine, for advice on the conduct of this experiment.

attributed to the deep diaphragmatic breathing of the trained men in contrast to the relatively shallow diaphragmatic breathing of the untrained men. Since rapid respiration tends merely to exchange air in the upper respiratory tract, the rate of breathing alone is not an accurate index of alveolar ventilation.

Vital capacity is "the maximum amount of gas that can be expelled from the lungs by forceful effort following a maximal inspiration" (4). The average vital capacity of American males has been given as 4,000 cc. (11), a value which Motley (17) considers much too low. Peabody and Wentworth (18) observed that the average vital capacity of ten highly trained American male athletes was 120 per cent of normal by American standards, and Kroll (12) reported that the mean vital capacity for a group of Big Ten varsity wrestlers was 5,134 cc.

Twenty years ago Cureton (5) wrote, "The evidence is very slight that there is any circulatory-respiratory condition measured by vital capacity . . . no positive relation can be claimed between vital capacity and organic condition." More recently, he suggested that individual norms for young men may be predicted by the formula:

$$\text{Vital Capacity (cubic inches)} = 309\ (M^2BSA)^2 - 273$$

The difference between the observed capacity and the predicted capacity, which he termed the "residual," indicates whether an individual has a vital capacity greater or less than the average young man of similar body surface area. He stated (6) that: "High plus residuals mean that the subjects very probably have relatively greater flexibility of the chest walls, greater strength and range of action in the diaphragm and in the respiratory muscles of the chest, and also greater strength and range of action of the expiratory muscles of the abdomen and chest. In this sense the residuals are true fitness measures." Other authors (4) have defined the residual as "the volume of gas remaining in the lungs at the end of a maximal expiration."

The relationship between vital capacity and physical fitness has long been a matter of dispute. Lemon and Moersch (13) stressed the importance of physical fitness and muscular development on vital capacity. Karpovich (11) commented, "there are reasons for believing that its magnitude bears an important relationship to the physical fitness of the person," and "there is some relationship between participation in physical work and vital capacity." However, Gordon, Levine, and Wilmaers (9) reported that the vital capacity of marathon runners in the 1924 Boston race was normal for their size and that there was no relationship between vital capacity and the order in which the runners finished. Morehouse and Miller (15) suggested that the respiratory superiority of the trained athlete lies in his greater ability to utilize his maximal lung capacity rather than in his increased vital capacity.

The vital capacity of an individual varies from day to day and also within any one day. These variations are primarily the result of fluctuations in

[2] Square meters of body surface area.

inspiratory effort (7). Tuttle (23) observed that a reduction in body weight tended to diminish vital capacity. Tables are available from data obtained by Baldwin, Cournand, and Richards (2) which may be used to predict vital capacity on the basis of height and age. Asserting that values obtained by this formula were too low, Pemberton and Flanagan (19) prepared a nomogram based on age, height, and weight, which they considered to be more accurate.

Segal and his co-workers (22) commented that "the main shortcoming of the vital capacity as a pulmonary function test is its lack of time relationship." The capacity of the lungs for maximum ventilation depends both on the vital capacity and the speed with which the volume can be exchanged, the speed of exchange being affected by the resistance of the respiratory passages to air flow and by the resistance of the lungs and thorax to changes in shape incidental to breathing. Thus, vital capacity alone does not afford a satisfactory indication of maximum ventilation. This shortcoming was apparently first recognized by Gaensler (8), who devised a technique of timing expiration. After studying a group of normal adult male and female subjects, he reported that the volume of air exhaled during the first second was 82.7 per cent of the vital capacity; that exhaled during the first two seconds was 94.7 per cent of the vital capacity; that exhaled during the first three seconds was 97.2 per cent of the vital capacity. In Motley's experience (17), however, a normal subject under 35 years of age exhaled 100 per cent of his vital capacity in three seconds and his vital capacity equaled 80 per cent of his total lung capacity. In a subject 35 to 60 years of age the vital capacity equaled 75 per cent of the total lung capacity; in one above 60 years of age, 70 per cent.

Tidal volume is "the volume of gas inspired or expired during each respiratory cycle" (4). Since ventilation of the lungs during exercise is probably adequate for normal oxygen saturation of the blood flowing through them, tidal volume alone is not useful as an index of alveolar ventilation. Tidal volume multiplied by respiratory rate indicates the minute volume of ventilation. This measurement is valuable in detecting subnormal ventilation of the lungs. Average values for resting normal adult males are approximately 3 to 4 liters per minute per square meter of body surface for minute volume and about 2 to 2.5 liters per minute per square meter for alevolar ventilation (4).

For moderate work, a linear relationship exists between total ventilation and the amount of work performed. When the intensity of work is increased to the point that a steady state cannot be maintained, pulmonary ventilation becomes excessive. Excessive ventilation serves no useful purpose, however, because at this point delivery of oxygen to the tissues becomes limited by the inability of the circulatory system to take up additional oxygen and deliver it to the heart, brain, and skeletal muscles. Hence, minute volume of breathing is not likely to be a limiting factor in exercise (7).

Since the muscles of a trained man function with a lower expenditure of energy than those of an untrained man, the former breathes less air to accomplish the same amount of work. Training reduces the respiratory rate and increases respiratory depth. In subjects studied by Schneider and Ring 21), minute volume decreased 15 to 17 per cent after several weeks of training. Well-trained male subjects 20 to 30 years old studied by Astrand and Rhyming (1) reached a maximum oxygen intake (aerobic capacity) of 3.37 to 4.85 liters/min. or 50.4 to 66.8 mg/kg/min. They suggested that maximum oxygen intake probably varies with the muscular mass.

Inspiratory reserve volume is "the maximal amount of gas that can be inspired from the resting end inspiratory position." Expiratory reserve volume is "the maximal volume of gas remaining in the lungs at the end of a maximal expiration" (4). According to Motley (17), the expiratory reserve is about one-third of the inspiratory reserve. The writers have not discovered any data relating these two measurements to the physical fitness of athletes.

Maximal breathing capacity, which is "the maximal volume of gas that can be breathed per minute" (4), is considered to be the best measure of maximal respiratory effect. Baldwin, Cournand, and Richards (2) found a significant negative correlation between maximal breathing capacity and age, a positive correlation with height, and no significant correlation with either body weight or body surface area. They stated that in males maximal breathing capacity correlated +0.777 with vital capacity, but other researchers reported that there is no significant correlation between these two measures. Comroe (3) explained these latter findings as follows: "The ability of a patient to breathe at sustained high velocity depends upon factors in addition to vital capacity; these probably include muscular force, patency of airways, pulmonary elasticity and distensibility."

Baldwin, Cournand, and Richards (2) prepared tables in which maximum breathing capacity for normal males (standing) was predicted by the formula: maximum breathing capacity/sq. m. BSA in liters/min. equals 86.5 (0.522 $\times$ age in years). Their formula was based on the use of a 9-liter respirometer. Motley utilized a 13.5-liter respirometer, which had less resistance than the 9-liter model, and reported their values were too low. He suggested (16) that the maximum breathing capacity in adult males should be calculated by the formula: maximum breathing capacity equals (97 — age/2) $\times$ M^2BSA, with a standard deviation of 13 "per cent."

Procedure

A Collins respirometer (13.5 liters), the bell of which was filled with oxygen, was used for this study. The respirometer was equipped with a pen for recording the customary spirogram to show the amount of air absorbed by the subject per unit of time and with a Reichert-type unit for recording the ventilogram to indicate the rate and amount of pulmonary ventilation during that time (20). After explanation and demonstration of the recording proce-

dure to the subject, a special minimum dead-space Bennett mask, which had been further modified by sealing off the inspiratory valves and removing the expiratory valves, was fitted over his mouth and nostrils. The mask was secured in place by means of a specially designed rubber head harness. Each subject stood in a comfortable stance.

The recording procedure consisted of three steps.

Step 1: The kymograph was set on "slow." The subject was instructed to breathe normally for two or three minutes in order to record simultaneously the respiratory rate and tidal volume.

Step 2: The apparatus was switched to "fast." The subject was instructed to take a maximum inhalation followed by a single forced maximum exhalation in the shortest time possible in order to record simultaneously his vital capacity and timed vital capacity. The subject was then directed to breathe normally for a short period, after which the measurement was repeated and the subject allowed to recover.

Step 3: The subject was instructed to make forced inhalations and exhalations at his maximum rate for a period of 15 seconds in order to obtain a record of his maximum breathing capacity. Following a rest period, this measurement was repeated.

Results and Discussion

The age and physical measurements of the subjects are presented in Table 1. Measurements of pulmonary function are presented in Table 2. The latter were compared with values for normal males of similar size predicted by the standard formulae to determine whether significant differences existed.

TABLE 1
Age and Physical Measurements of the Subjects

Subject	Age (Years)	Height (Inches)	Weight (Pounds)	Body Surface Area (Sq. Meters)
1	25	65.0	128	1.64
2	22	65.5	142	1.72
3	26	68.0	150	1.81
4	25	66.0	154	1.79
5	27	72.0	177	2.02
6	24	73.0	187	2.09
7	24	74.0	204	2.19

The mean vital capacity of the subjects was 5,232 cc., which was slightly greater than Kroll's figure of 5,134 cc. Undoubtedly, this difference would have been greater had it been possible to include the Olympic heavyweight wrestler. The mean vital capacity of the subjects was 16 per cent greater than that predicted by the Baldwin-Cournand-Richards formula and 4 per cent greater than that predicted by Pemberton and Flanagan. Thus, the Pemberton-Flanagan nomograph predicted the observed vital capacities of this select group of athletes more accurately than did the older formula. Al-

TABLE 2

Measurements of Pulmonary Function (In Cubic Centimeters)[1]

Subject	1	2	3	4	5	6	7
Vital Capacity							
Observed	4406	5252	4050	5651	5651	5696	5918
B. C. & R. Predicted	4092	4185	4168	4275	4502	4630	5850
Diff. Obs.-Pred.	+ 314	+1067	− 118	+1376	+1149	+1066	+ 68
% Diff./Pred.	+ 08	+ 25	− 03	+ 32	+ 26	+ 23	+ 01
Cureton Cal.	3831	4228	4588	4687	5755	6109	6616
Obs.-Cal.	+ 575	+1024	− 538	+ 964	− 104	− 413	− 698
% Resid./Cal.	+ 15	+ 24	− 12	+ 21	− 02	− 06	− 11
Pemberton-Flanagan Pred.	4510	4650	4870	4640	5300	5500	5641
Diff. Obs.Pred.	− 94	602	− 820	+1011	+ 351	+ 196	+ 277
% Diff./Pred.	− 03	+ 13	− 17	+ 22	+ 07	+ 04	+ 05
Timed Vital Capacity							
Exhaled 1 Sec.	3472	4228	3701	4272	4495	4490	4495
% Exhaled 1 Sec.	78.8	80.5	91.4	75.6	79.5	78.8	76.0
Gaensler Norm. (%)	82.7	82.7	82.7	82.7	82.7	82.7	82.7
Diff. Norm.-Obs.	+ 03.9	+ 02.2	− 08.7	+ 07.1	+ 03.2	+ 03.9	+ 06.7
Exhaled 2 Sec.	4184	5207	3872	5073	5296	5591	5296
% Exhaled 2 Sec.	97.2	99.1	95.6	89.8	93.7	98.2	89.5
Gaensler Norm. (%)	94.7	94.7	94.7	94.7	94.7	94.7	94.7
% Diff. Norm.-Obs.	+ 02.5	− 04.4	− 02.6	+ 04.9	+ 01.0	− 03.5	+ 05.2
Exhaled 3 Sec.	4406	5252	4050	5385	5518	5696	5874
% Exhaled	100	100	100	95.3	97.6	100	99.3
Gaensler Norm. (%)	97.2	97.2	97.2	97.2	97.2	97.2	97.2
% Diff. Norm.-Obs.	− 02.8	− 02.8	− 02.8	+ 01.9	− 00.4	− 02.8	− 02.1
Total Lung Capacity (Motley)	5508	6565	5063	7063	7065	7120	7398
Maximum Breathing Capacity							
Observed	139.96	179.24	169.42	161.83	166.96	179.34	148.21
Motley Predicted	138.58	147.92	151.26	152.04	168.67	177.65	186.15
Diff. Obs.-Pred.	+ 1.38	+ 31.32	+ 18.16	+ 9.79	− 1.71	+ 1.69	− 37.94
% Diff./Pred.	+ 01.00	+ 21.17	+ 12.00	+ 06.44	− 01.01	+ 0.[illegible]	− 20.38
B. C. & R. Pred.	121.00	129.00	132.00	131.50	146.00	155.00	162.06
Diff. Obs.-Pred.	+ 18.96	+ 50.24	+ 37.42	+ 30.33	+ 20.96	+ 24.34	− 13.85
% Diff./Pred.	+ 15.66	+ 38.94	+ 28.35	+ 23.06	+ 14.36	+ 15.70	− 08.55

1 Corrected to 760 mm. Hg., 37° C., saturated.

though the values for vital capacity for champion wrestlers exceeded those predicted by the Baldwin-Cournand-Richards formula, the difference as computed by Fisher's "t" was significant only at the 5 per cent level of confidence. It does not appear that the vital capacities of these Olympic wrestlers were significantly greater than those predicted for normal young men of equivalent size by these standard tables or graphs.

On the assumption that these wrestlers were in a state of high physical fitness, it had been anticipated that computations according to the Cureton formula would show comparatively large plus residuals. The results, however, were inconsistent; three of the wrestlers showed plus residuals and four showed minus residuals. Among the latter was a contestant who wrestled consecutively three opponents on the evening the above tests were made and who, to all outward appearances, was in better condition than any of the wrestlers present that night. On the basis of this study, it is not apparent how these residuals could be employed to evaluate the comparative fitness of individual wrestlers. Rather, the evidence tends to support the accuracy of Cureton's earlier statement that a positive relationship between vital capacity and organic condition cannot be shown.

Values for timed vital capacity presented an interesting deviation from the predicted norms. Gaensler's subjects exhaled 82.7 per cent of their air during the first second and 94.7 per cent during the next second. The authors' subjects exhaled only 80.1 per cent of their air during the first second, but averaged 94.7 per cent during the next second. Since Gaensler used a mixed population, the results were not strictly comparable, and it appeared that further statistical comparisons of observed timed vital capacities of the wrestlers with Gaensler's predicted values would be meaningless. Possibly these differences reflected only a sex factor.

The mean observed maximum breathing capacity of these subjects was 18 per cent greater than that predicted for normal males of equivalent body size by the Baldwin-Cournand-Richards formula, but only 3 per cent greater than that predicted by the Motley formula. When the difference between the observed maximum breathing capacity and the Motley predicted capacity was tested by Fisher's "t" technique, it was found to be without statistical significance.

Conclusions

Measurements of pulmonary function in members of the United States Olympic Free Style Wrestling Team were recorded. The data obtained support the following conclusions:

1. The vital capacities of the subjects were not significantly greater than those predicted for normal adult males by the Pemberton-Flanagan nomogram.

2. Values recorded for the one-second timed vital capacity of these subjects differed from those reported by Gaensler, but this difference may have resulted from the fact that his subjects included both sexes.

3. The maximum breathing capacities of these subjects did not differ significantly from those predicted by the Motley formula.

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Comparative Study of Physiological Effects of Two Ski-Training Methods

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Abstract

In this study two groups of students, 20 subjects in all, were given 10 physical tests at the beginning and at the end of an 8-week ski-training period. Using the t-test, statistically significant differences between the first test and the second test in the total group of subjects were found in the following tests: breath holding, pulse rate on bicycle ergometer work, recovery pulse, floor push-ups, full squat jumps, agility exercise, time of the skiing race, and time of the last 2 km in skiing race.

Statistically significant differences between the mean gains were found in breath holding and spurt ability in skiing in favor of the interval training group, and in floor push-ups in favor of the constant speed training group.

ALTHOUGH cross-country skiing has been one of the most popular sports in Finland for years, little attention has been given to the effects of different ski-training methods upon the physical fitness of skiers (1).

The purpose of the present investigation was to compare the physiological effects of two different ski-training methods: namely, the "interval training method" and the "constant speed training method."

In the "interval training method" hard work and rest interchange in a specified manner, and in the "constant-speed training method" the skier is skiing the whole distance at a specified, constant speed.

Procedure

It was assumed that ski training results in rather well-defined changes in the physiological condition of skiers. As a means of measuring the extent to which such changes occurred, the following tests were selected for use.

1. *Respiratory tests*
   (a) Vital capacity
   (b) Running in place for 2 min. (speed 180 steps/min.), and subsequent breath holding.
2. *Cardiovascular tests*
   (a) Pulse rate during work on a bicycle ergometer. The work lasted 10 minutes during which the load increased evenly from 10 kg/m/sec. to 20 kg/m/sec. The pulse was counted with a German pulse counter (2).
   (b) Recovery pulse. The pulse was counted with the same pulse counter during a recovery period of 3½ minutes.

3. *Motor fitness tests*
   (a) Floor push-ups (maximum number)
   (b) Sitting tucks (maximum number)
   (c) Full squat jumps (maximum number)
   (d) Trunk extension and down (maximum number)
   (e) Agility six-count exercise: Squat—extend legs backward—extend legs forward—flip over—return to squat-rest position—return to standing position (six times, as fast as possible).
4. *Skiing race in order to measure the spurt ability*
   The spurt ability was measured as follows: The average speed on a 15-km cross-country skiing race was taken and compared to the speed on the last 2 km in the same race, which was considered the spurt stretch of the race. The extent to which the speed on the last 2 kilometers was increased from the average speed during the whole race was considered the man's spurt ability.
5. *Blood tests*
   Hemoglobin percentage was determined, and red and white blood cells and eosinophil percentage were counted.

Subjects

Twenty men taking part in the Sports Instructor Course at the Sports Institute of Finland were selected for this study. These subjects were tested before the training period (February 2 to February 4) and again after the training period (March 28 to March 30). The subjects were not allowed to practice exercises included in the test battery. Also, all extra training outside the course was prohibited during the ski-training period. During the ski-training period, the subjects part in the usual course program, which included 100 theoretical lessons and 100 practical lessons in skiing, volleyball, basketball, and gymnastics.

Ski-Training Methods

The group of 20 subjects was divided into two equal groups by drawing lots. Group A started the interval training and group B the constant-speed training. The training extended over a period of eight weeks, each week including three periods of 60 minutes each.

TRAINING METHOD OF THE CONSTANT-SPEED GROUP

The skiing tracks of different lengths at the Sports Institute were used in training. In that way it was possible to determine the distance covered during one training period. Fixing the right speed according to one's condition and skiing skill was done during the first three training periods by the test leader, but after that the subjects were allowed to adjust their own speed individually. It was the purpose to fix the speed so that it was possible to maintain it during the whole training period of 60 minutes.

The average speed of this group during the whole training period (8 weeks) was 10.15 km/hour. The average competition speed (determined in

two different races of 15 km) was 11.53 km/hour. The training speed was thus 88 per cent of the competition speed.

No actual warm-up was given before the training periods, because the trial-skiing combined with ski-greasing, as well as the previous sport activities, were thought to be sufficient.

TRAINING METHOD OF THE INTERVAL TRAINING GROUP

A warm-up period of 15 minutes preceded the training period. After that the subjects started the training at 1 min. intervals. The track used in the training procedure was 2 km long and reasonably flat, the greatest change in height over the entire course being 5 meters. The training was carried out in the following way:

Training Time	*Recovery Time*	*Average No. of Rounds*	*Speed*
1–2 week	5 min.	4	14.33 km/hour
3–6 week	4 min.	4.5	14.28 km/hour
7–8 week	3 min.	5.5	13.21 km/hour

The average speed during the whole training period was 13.94 km/hour. The average competition speed determined in two different competitions of 15 km was 11.78 km/hour. The training speed was thus 118 per cent of the competition speed.

During the recovery period the subjects were skiing very slowly just to keep themselves warm enough for the next round.

Analysis of Data

The mean gains in test scores made by the total group of subjects were first calculated. The same calculations were made for the two training groups separately. Because the purpose was to determine which one of the two training methods used in this study had more influence upon the test results, i.e., improved the skiers' condition, it was necessary to make comparisons between the mean gains of these two groups. The t-test was used to determine the significance of the obtained differences in mean scores between the first test and the second test for the total group of subjects and to determine the significance of the obtained differences in gains between the two training groups.

The mean scores made by the total group of subjects at the beginning and at the end of an eight-week period are shown in Table 1. The subjects showed a statistically significant increase in all but the tests of vital capacity, sitting tucks, trunk extension, and spurt ability. The levels of statistical significance for all tests may also be found in Table 1.

The mean difference in score between the first test and the second test of the two training groups may be found in Table 2. The values of t and the levels of statistical significance for the tests are also shown in Table 2.

TABLE 1
Significance of Differences Between the Before and After Training Test Scores of the Total Group of Subjects

Test	Before Training Mean Scores	After Training Mean Scores	Change Mean	Level of Significance %
Vital capacity	4.91 liters	4.99 liters	+ 0.08 liters	—
Breath holding	23.1 sec.	31.2 sec.	+ 8.1 sec.	.01
Pulse rate on bicycle ergometer work				
1 min.	109.1	101.8	− 7.3	.05
2 min.	118.3	109.1	− 9.4	.01
3 min.	123.3	112.2	−11.1	.001
4. min.	127.0	115.1	−11.9	.001
5 min.	129.6	119.2	−10.4	.001
6 min.	133.1	123.3	− 9.8	.001
7 min.	137.9	127.3	−10.6	.001
8 min.	142.1	131.2	−10.9	.001
9 min.	145.0	134.8	−10.2	.001
10 min.	149.1	137.2	−11.9	.001
Recovery pulse				
0–1 min.	128.3	109.9	−18.4	.001
1–2 min.	102.8	87.7	−15.1	.01
2–3 min.	96.4	85.2	−11.2	.01
Sum of pulses in recovery 1–1½, 2–2½, and 3–3½ min. after the work	147.8	129.8	−18.0	.01
Floor push-ups	25.2 times	30.1 times	+ 4.9 times	.01
Sitting tucks	55.3 times	57.1 times	+ 1.8 times	—
Full squat jumps	76.3 times	92.9 times	+16.6 times	.05
Trunk extension and down	35.6 times	39.5 times	+ 3.9 times	—
Agility 6-count exercise	20.8 sec.	18.8 sec.	− 2.0 sec.	.001
Time of 15-km. skiing race	78.99 min.	67.28 min.	−11.71 min.	.01
Time of the last 2 km. in 15-km. skiing race	10.63 min.	8.10 min.	− 2.53 min.	.001
Spurt ability in skiing	0.48 min.	0.53 min.	+ 0.05 min.	—

Conclusions

Statistically significant gains in test results during the ski training were found in the following tests: breath holding, pulse rate on bicycle ergometer work, recovery pulse, floor push-ups, full squat jumps, agility exercise, time of the skiing race, and time of the last 2 km in skiing race.

This indicates very clearly that ski training, which lasted eight weeks, had a strong influence on the skiers' physical fitness as measured by these tests. It must be pointed out, however, that 100 practical lessons in skiing, volleyball, basketball, and gymnastics during the ski training period must have had some influence upon the test results. When skiers are training for skiing, they also are taking part in some other sports at the same time. Therefore,

TABLE 2

Significance of Differences Between Main Gains of the Two Training Groups

Test	Interval Training Group Mean Change	Constant Speed Training Group Mean Change	t	Level of Significance %
Vital capacity	+ 0.11 l.	+ 0.04 l.	0.98	—
Breath holding	+12.7 sec.	+ 3.4 sec.	2.14	.05
Pulse rate on bicycle ergometer work				
1 min.	— 4.6	−10.0	0.93	—
2 min.	— 5.4	−13.4	1.62	—
3 min.	— 7.4	−14.8	1.59	—
4 min.	— 8.1	−15.7	1.59	—
5 min.	— 7.0	−13.9	1.59	—
6 min.	— 6.6	−13.0	1.40	—
7 min.	— 6.0	−15.2	2.16	.05
8 min.	— 7.5	−14.3	1.58	—
9 min.	— 6.4	−13.9	1.72	—
10 min.	— 8.9	−14.8	1.41	—
Recovery pulse				
0–1 min.	−12.2	−24.7	1.44	—
1–2 min.	— 9.0	−21.3	1.62	—
2–3 min.	— 4.7	−17.7	1.80	—
Sum of pulses in recovery 1–1½, 2–2½, and 3–3½ min. after the work	— 8.9	−27.1	1.58	—
Floor push-ups	+ 1.8 times	+ 8.0 times	2.92	.01
Sitting tucks	0	+ 3.5 times	0.39	—
Full squat jumps	+26.8 times	+ 6.5 times	1.40	—
Trunk extension and down	+ 5.1 times	+ 2.8 times	0.41	—
Agility 6-count exercise	— 1.8 sec.	— 2.3 sec.	0.61	—
Time of 15-km. skiing race	−14.22 min.	— 8.88 min.	0.80	—
Time of the last 2 km. in 15-km. skiing race	— 2.96 min.	— 2.02 min.	0.94	—
Spurt ability in skiing	+ 0.16	— 0.08	3.42	.01

the conditions and program in this study were nearly similar to the conditions in actual training of skiers.

The following conclusions can be drawn from the comparisons made between the effects of the two different ski-training methods:

1. No significant difference between the mean changes in vital capacity was found.

2. The difference between the mean gains in breath holding was found to be significant at the five per cent level in favor of the interval training group. The t-test thus favors the hypothesis that interval training increases one's breath holding ability. This seems natural, because the purpose of the

interval training is to make skiers accustomed to endure severe strain and oxygen debt, and in breath holding similar qualities are needed.

3. Pulse rate on bicycle ergometer work. After the ski-training period, pulse rate decreased in bicycle ergometer work compared to the pulse rate in the same work done before the training period. Apparently this means that the heart has become stronger during the ski-training period. As a whole, no statistically significant differences were found between the changes in the two training groups.

4. The recovery pulse after the bicycle ergometer work. The pulse returned to normal faster and the pulse rate decreased more after the training period as compared to that before the training period. This indicates increased fitness of the heart. No significant difference between the mean gains in recovery was found.

5. The difference between the mean gains in floor push-ups was significant at the 1 per cent level in favor of the constant speed group. Additional studies are needed to explain this difference.

6. No differences of statistical significance were found between the mean gains in sitting tucks, full squat jumps, trunk extension, and agility exercise.

7. The spurt ability in skiing. In spurt ability, which here means the ability to increase one's speed during the last two kilometers as compared to the average speed during the whole race, the difference between the mean gains was found to be significant at the 1 per cent level in favor of the interval training group. The result strengthens the coaches' opinion that interval training is the best way to develop the spurt ability of skiers.

Summary

Two groups of students of the Sports Instructor Course at the Sports Institute of Finland, 20 subjects in all, were used to study whether a specified amount of time spent in practicing two different ski-training methods would result in significant changes in the physical fitness of the subjects. Ten different tests were administered at the beginning and at the end of an eight-week ski-training period. The t-test was used to determine the significance of the obtained differences in mean scores between the first test and the second test in the total group of subjects and to determine the significance of the differences in gains obtained by the two training groups.

Statistically significant differences between the first test and the second test in the total group of subjects were found in the following tests: breath holding, pulse rate on bicycle ergometer work, recovery pulse, floor push-ups, full squat jumps, agility exercise, time of the skiing race, and time of the last 2 km in the skiing race.

Statistically significant differences between the mean gains were found in breath holding and spurt ability in skiing in favor of the interval training group, and in floor push-ups in favor of the constant-speed training group.

No statistically significant changes were observed in hemoglobin determination, in the number of red and white blood cells, or in the eosinophil percentage.

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Ratio of Physical Development as a Factor in Motor Co-ordination of Boys Ages 10-14[1]

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Abstract

A battery of eight co-ordination test items, based on a factor analysis of motor co-ordination tests, was administered to 118 boys in grades five through eight. Developmental ratios were found for the subjects through a quotient of developmental age, as determined by the Wetzel Grid, and chronological age. Subjects were divided into three groups according to their developmental ratios, and individual co-ordination items were statistically examined between groups. No significant differences were found between the accelerated, average, and retarded growth groups on any area of motor co-ordination studied.

THE TEACHER of physical education is in constant need of principles relating to pupil capacities in motor achievement. It is becoming increasingly important that there be general understanding of the limitations placed on an individual student's potential in physical performance by certain physical traits. Physique, chronological age, and size are examples of traits which have undergone study (1, 5, 11). There have been few studies concerned with the influence of the degree of physical development to such motor abilities.

Yet it seems important that this problem be considered. It is common for low levels of achievement in motor skills to be excused on the basis of the pupil's being too big for a given age or growing too fast. Many have accepted the hypothesis that periods of rapid growth are characterized by corresponding low levels of motor achievement. The upper elementary school is a popular level for this belief because of the differences in quantity of growth of boys at this stage of development. Such beliefs are empirical, since little scientific study has been done to substantiate or deny them.

Statement of the Problem

The purpose of this study was to determine the relative effect of varying ratios of physical development on the performance of selected motor co-ordination tests. The question to be answered was whether or not basic differences in motor co-ordination existed between groups of upper elementary school boys (grades five through eight) who have shown average, retarded,

[1] This study was made while the author was a member of the faculty at Wisconsin State College, River Falls.

or accelerated physical development compared to children of comparable chronological ages.

RATIO OF PHYSICAL DEVELOPMENT

The ratio of physical development was determined in this study by the quotient of the subject's developmental age as determined by the Wetzel Grid and chronological age. This quotient is termed *developmental ratio* by Wetzel (13). The quotient was multiplied by one hundred to eliminate decimals from computations. The ratio of physical development may be represented by the formula

$$\text{Ratio of physical development} = \frac{\text{average age of boys of same size}}{\text{Subject's own chronological age}} \times 100.$$

MOTOR CO-ORDINATION

This factor, common to all physical activity, apparently means many things to many people. It has been the subject of much investigation, but no one has successfully defined it to the extent that there is a generally acceptable measuring device available for use. The conventional practice appears to have been the selection of items suspected of offering general selectivity in specific abilities, narrowing the battery to non-related items, and statistically weighting such items so that the battery has a specific predictive value. Examples of such tests are on motor educability (7, 9, 10) and general motor ability (2, 3, 6, 12).

Cumbee (4), utilizing factor analysis techniques, has narrowed the host of conventionally used items in the measurement of motor co-ordination to eight independent classes. These classes included items of balancing objects, tempo, two-handed agility, speed of change of direction of hands and arms, and body balance. Two classes of items were unnamed, although one of the two seemed to involve perception in measuring the speed of a moving ball and manipulating the body parts to catch it. The eighth class, quite often referred to in itself as motor co-ordination, was considered by the author to be misnamed. It was suggested that items such as side-stepping, running a zig-zag line, and dodging be used in measuring this factor. Since complete identification of all eight factors could not be made, no weighted formula was given for the measure of motor co-ordination.

The test items for this study devised to measure co-ordination were based on Cumbee's factor analysis. Five of the items were designed to test *tempo, balancing objects, static body balance, two-handed dexterity,* and *quick change of direction of the upper trunk and arms.* At the suggestion of Cumbee, a sixth item, the zig-zag run, was included to measure *total body change of direction.* A large number of prospective items believed to measure each of these classes within motor co-ordination were devised and administered to a class of upper elementary boys, ages 10 to 14. After carefully screening on the basis of difficulty to subjects, ease of administration, objectivity of scores, and ability to discriminate between subjects, a battery of six items,

one to measure each class, was finally selected. Two items, the *vertical jump* and the *squat thrust,* were added arbitrarily because of their frequent use in physical testing.

Specific items selected for the battery and their means of measurement were as follows:

Tempo. Measured in terms of the divergence in number of arm thrusts at a specified tempo for a given period of time from the number of thrusts in an equal period of time at a rate remembered by the subject from the first performance. A rate of 60 thrusts per minute was established in the first 30-second period by use of a metronome with both audio and visual signals.

Balancing objects. Measured as the length of time the subject could balance a wand on the index finger, moving freely about the gymnasium floor.

Static body balance. Measured as the length of time the subject could remain balanced on a simple balance beam in an upright stance.

Two-handed dexterity. Measured in terms of the number of times the subject could bounce a ball against a wall and catch it with the opposite hand. The ball was alternately thrown and caught with opposing hands. No particular rate was established. The subject stood at a distance equal to his height from the wall. The ball had to be clearly caught in the hand, and could not touch the floor at any time.

Quick change of direction of the upper trunk. Measured as the number of times the hands, clasped together, could be transferred from the floor on one side of the body to the floor on the other side, the lower body remaining stationary. The subject sat with feet spread to shoulder width. The test began with the hands on the side of the preferred arm.

Total body change of direction. Measured as the length of time needed to traverse a zig-zag course. From the starting point the first obstruction was 10 feet ahead and seven and one-half feet to the right. The second obstacle was 20 feet ahead and seven and one-half feet to the left, and the third obstacle was 30 feet ahead. Subjects were instructed to run around the outside of each obstacle in the order listed, and to retrace their course in reverse order so that they ended in the starting position.

Vertical jump. Measured as the difference in inches between the maximum reach from the standing position and the maximum jumping height.

Squat thrust. Measured as the number of completed squat thrust movements in a 30-second period of time.

Experimental Procedures

DETERMINING DEVELOPMENTAL AGE AND RATIO

The Wetzel Grid was used in finding the developmental age of each subject. The developmental age for a given subject is measured in terms of the chronological age of children with the same degree of physical development, or size, who are considered standard or normal in the entire population in terms of growth. By comparing this measure with the actual chronological age, the degree of normalcy, retardation, or acceleration may be found. In this study the ratio of the subject's developmental age to his chronological age was used for comparison. This numerical value is termed developmental ratio by Wetzel (13). Single measurements of height and weight, as were made in this study, can give only a comparison of actual physical growth to that of average, or normal growth. It should not be implied that those falling in any of the three groups studied are either successful or unsuccessful in growth, because it is fundamental that each child establishes his own

growth curve which may or may not approximate that of the average in the entire population.

To find developmental ratio, the subject's height and weight were found on the appropriate scales at the top and left margins of the grid panel, and lines were extended from these points until they met on the panel. Developmental level of the subject was then read from the left margin of the physique channels at a point corresponding to the point at which these two lines met. By extending this developmental level, a measure of size, until it intersected the 67 per cent auxidrome, the expected age of children of the same size was read from the age scale at the age corresponding to the point of intersection. The formula for level of physical development was then applied.

RELIABILITY OF TEST ITEMS

The test-retest method of determining the degree of reliability of items in the final battery was used. The battery was administered to 20 fifth and sixth grade boys, and after a week had elapsed, the same tests were repeated. Pearson product-moment coefficients of correlation were computed for the two sets of scores on each of the eight test items. Table 1 shows the result of these correlations.

TABLE 1
Reliability Coefficients of Test Items

Test item	r
Tempo	.48
Balancing objects	.72
Static body balance	.72
Two-handed dexterity	.71
Upper trunk change of direction	.83
Total body change of direction	.87
Vertical jump	.89
Squat thrust	.85

With the exception of the arm thrust movement designed to measure *tempo,* all items were deemed satisfactory from the standpoint of reliability. The coefficient of correlation for tempo was .48. This was sufficiently low to make acceptance of the results of this study in terms of this factor questionable. It has been found in other studies that this item is extremely difficult to measure with reliability (4). All other items ranged from .71 to .89.

Administration of tests. Standardized instructions for administering the test items and recording the results were developed in the early stages of experimentation, and were used throughout the gathering of the final data. Every effort was made to measure initial levels of performance. However, each student was allowed enough practice on each item to insure his ability to perform the movement successfully. The final score on each test item was determined by the mean score on three successive trials. Students were con-

tinually encouraged to put forth their best efforts. Morale appeared to be high among the subjects at all times during testing.

The final battery of test items was administered to 118 boys at the fifth, sixth, seventh, and eighth grade levels. This group constituted the entire male population in these grades in the public schools of this city. The number of subjects differed from item to item because of absences from school. The number of subjects for the items *vertical jump* and *squat thrust* was considerably smaller since both were added after the pilot study had been made.

The regularly scheduled physical education period for each class was utilized for the final testing. Classes met two days per week on alternate days. The battery of tests was divided into two parts in order to facilitate testing. On the first day of testing the subject's height and weight and scores for *tempo, upper body change of direction, vertical jump,* and *squat thrust* were determined. The remainder of the items were administered in the next physical education period. Two of the items, *upper body change of direction* and *squat thrusts,* were administered through group testing procedures. All other measurements were taken individually.

STATISTICAL PROCEDURES

Developmental ages and chronological ages were computed for the subjects specific to the date of testing. All ages were rounded to the nearest tenth of a year. The developmental ratios for all students were then determined through use of the formula previously presented.

The data cards for the 118 subjects were arranged in the order of their developmental ratios and then divided into three groups of approximately equal numbers on the basis of their comparative growth. Those with quotients ranging from 85 to 104 were classified as the retarded group, those from 105 to 113 as the average group, and those from 114 to 150 as the advanced group. This division was purely arbitrary with the one purpose of equalizing N in mind. The ranges and distribution of the ratios of physical development of the boys studied are shown in Figure I.

It may be noted that the boys in this study ranged considerably above the norms for growth indicated by the Wetzel Grid. Rather than the developmental quotient of 100 that could be expected for the average of the group studied, boys in this study showed a median developmental quotient of 110. This difference can probably be accounted for in terms of social and economic status and racial inheritance. Differences in size from national norms should have little significance in so far as comparison of co-ordination scores of groups differing in levels of physical development is concerned.

To determine the effect of ratio of physical development on motor co-ordination as measured, the differences in mean performances of the three groups, so classified because of ratio of physical growth, were statistically examined. No attempt was made to arrive at a composite score, and each item should be examined in terms of the reader's own beliefs as to the relative value in total motor co-ordination.

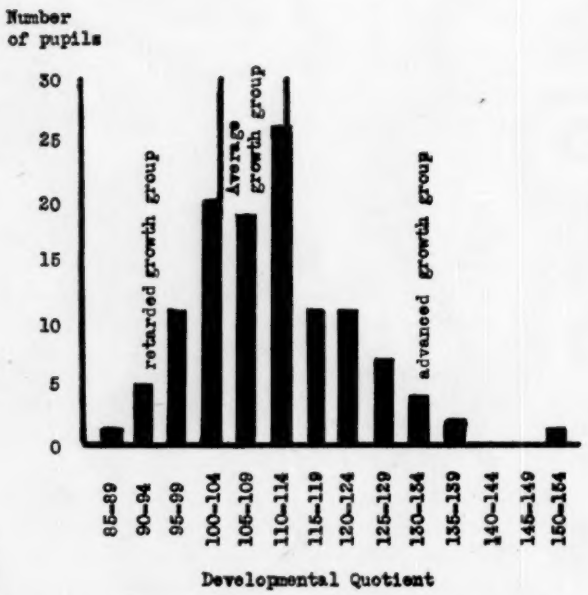

FIGURE I. Distribution of Subjects by Developmental Quotients.

Interpretation of Data

Means and standard deviations of the scores of the three groups on each item in the battery may be seen in Table 2. It may be noted that on the items *tempo, balancing objects, body balance,* and *two-handed dexterity* the distribution of scores was skewed. The mass of scores grouped themselves closely around the mean, but extreme scores at the upper end of the scale greatly increased the variability. The extremely high scores could have been avoided by placing an upper limit on performances as measured, but such a technique would have destroyed an important element of this study—to determine the relative bearing of such extremes on mean performances. The scores on the remainder of the battery appeared to be normally distributed.

The analysis of variance technique was employed to determine the statistical significance of observed differences between the experimental groups on the factors of motor co-ordination studied. This statistical procedure tests the hypothesis that all groups come from the same population in terms of the factor being studied. If this hypothesis cannot be rejected with confidence, no further tests between individual groups would be necessary, and it can be concluded that no real differences existed between any of the groups. On the other hand, rejection of the hypothesis would require further tests of significance between individual groups.

TABLE 2

Numbers, Means, and Standard Deviations of Experimental Groups on Co-ordination Test Items

Test items	Retarded Group			Average Group			Advanced Group		
	N	M	σ	N	M	σ	N	M	σ
Tempo	34	2.85	2.92	38	3.47	3.07	42	3.71	3.82
Balancing objects	33	6.07	3.66	37	7.85	9.56	41	7.74	8.17
Static body balance	34	21.85	15.64	37	19.42	15.63	41	16.64	15.00
Two-handed dexterity	36	11.81	8.69	35	9.27	11.51	42	10.86	7.14
Upper trunk change of direction	37	47.52	7.04	37	46.78	10.36	41	48.35	7.09
Total body change of direction	36	9.88	1.05	36	10.33	.97	42	10.20	.99
Vertical jump	24	12.50	2.58	20	11.43	3.05	32	11.73	3.36
Squat thrust	26	9.19	2.11	22	8.35	1.54	31	8.29	1.78

TABLE 3

L_1 Test of Co-ordination Scores of the Three Experimental Groups

Tempo	k	f_s	N	log N	$\frac{Zn(\log n)}{N}$	$\frac{Zn \log x)}{N}$	log Zx	log L_1	L_1
Tempo	2	37	114	2.05690	1.58139	2.61300	3.10106	9.98745—10	.9715
Balancing objects	2	36	111	2.04532	1.56989	3.23233	3.81704	9.89072—10	.7775*
Static body balance	2	35	112	2.04922	1.57337	3.94814	4.42406	9.99993—10	.9999
Two-handed dexterity	2	38	113	2.05308	1.56960	3.46760	3.97759	9.97349—10	.9408
Upper trunk change of direction	2	38	115	2.06070	1.58409	3.39031	3.89658	9.97034—10	.9440
Total body change of direction	2	36	114	2.05690	1.57710	1.58752	2.06781	9.99951—10	.9989
Vertical jump	2	23	76	1.88081	1.41198	2.36977	2.84942	9.98918—10	.9754
Squat thrust	2	25	79	1.89763	1.42474	1.93965	2.42732	9.98522—10	.9665

TABLE 4

Analysis of Variance of Mean Co-ordination Scores of the Three Experimental Groups

Test Item	Between Means			Within Groups			Total		
	df	ss	o^2	df	ss	o^2	df	ss	F
Tempo	2	14.48	7.24	111	1262.30	11.37	113	1276.78	.6368
Balancing objects	2	68.88	34.44	108	6562.26	60.76	110	6631.14	.5668
Static body balance	2	508.69	254.35	109	26565.37	243.72	111	27074.06	1.0436
Two-handed dexterity	2	116.33	58.17	110	9497.24	86.34	112	9613.57	.6737
Upper trunk change of direction	2	47.84	23.92	112	7880.95	70.37	114	7928.78	.3399
Total body change of direction	2	3.92	1.96	111	116.89	1.05	113	120.81	1.8667
Vertical jump	2	14.04	7.02	73	707.68	9.69	79	721.72	.7245
Squat thrust	2	13.43	6.72	76	266.14	3.50	78	279.57	1.9190

* Significant at beyond the 5 percent level of confidence.

Analysis of variance requires the assumption of homogeneity of variance. The Welch-Nayer L_1 Test was used in this study to test the degree to which this assumption was true in each of the eight motor co-ordination factors for the three groups under study. Table 3 shows the computations for L_1. For samples in which k equals two, and in which there are 38 degrees of freedom or less, an L_1 of .9390 or more would lack significance at the 5 per cent level. The hypothesis that the variances were from the same population could not be rejected at the 5 per cent level of confidence for any item except *balancing objects*. There appears to be an increasing belief that the F-test may give fairly reliable results when the variances of the particular groups being studied are not homogeneous. If this is accepted, interpretations of the item *balancing objects* may be accepted as readily as for the other seven items demonstrating homogeneity of variance.

Analysis of variance tests the hypothesis that all groups are from the same population in the motor co-ordination item tested. Table 4 shows the computations from which F for each item of the co-ordination tests was derived. In order for observed differences in means to be significant at the 5 per cent level of confidence on the factor *upper trunk change of direction* the obtained F needed to exceed 3.93. All other F's would have to be larger to balance the loss of reliability in using a smaller number of subjects. None of the F's obtained for the eight co-ordination items in this study exceeded this value.

The hypothesis that the retarded, average, and advanced groups in physical development were from the same population in terms of mean performances on the battery of eight co-ordination tests was highly tenable. Any observed differences could be readily attributed to chance.

Summary and Conclusion

It would appear that ratio of physical development was not a significant factor in the motor co-ordination items administered to the 118 boys ranging from age 10 to age 14 in this study. No significant differences were found in *tempo, balancing objects, static body balance, two-handed dexterity, upper trunk change of direction, total body change of direction, vertical jump,* or *squat thrust.* There was no evidence to support the claim that boys who are big for their age or small for their age may be expected to perform better or worse in physical skills from the standpoint of motor co-ordination.

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(Submitted 5/5/57)

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

Education

56. BAKER, B., *et al.* A further report on an experimental evaluation of mental hygiene techniques in school and community. *American Journal of Psychiatry,* **113:** 8 (Feb. 1957).

A study of mental health workshops for teachers and parents was carried on in Westchester County, New York. There was both a control set of groups and an experimental one. All groups were given psychological tests before and after the workshops. The statistical analysis of the results led to several conclusions, including the following: (1) The experimental groups as a whole showed more changes in a position direction than did the control groups; (2) the parents of the experimental groups showed greater over-all changes than did the teachers as compared with the changes in the control groups; (3) the most striking positive changes were obtained on the Parental Survey Scale for all of the experimental groups.—*Edna Willis.*

57. CAPPS, M., and F. DECOSTA. Contributions of the graduate record examinations and the national teachers examinations to the prediction of graduate school success. *J. of Educational Research,* **50:** 5 (Jan. 1957).

The study was conducted to determine the extent to which scores made on each of three Graduate Record Examinations (Profile Test, Aptitude Test, and Advanced Test in Education), the scores made on the Comprehension Examination of the National Teachers Examination, and undergraduate grade-point averages were related to graduate school success in the case of students in the School of Graduate Studies of South Carolina State College, and to determine relationships between various combinations of scores and success in graduate school work. Success in graduate work was based on grades made in four subjects.

It was found that the best single predictor of graduate school success was the Advanced Education Test of the Graduate Record Examination ($r = 49$). Four combinations of predictors were found to be of equal value in predicting success. It was also found that the Profile Tests of the Graduate Record Examination, either singly or in combination with other predictors, was of little value in predicting success.—*Edna Willis.*

58. JONES, MARGARET L. Analysis of certain aspects of teaching ability. *J. of Experimental Education,* **25:** 2:153-180 (Dec. 1956).

Forty-six secondary school women teachers, randomly drawn from graduates of the University of Wisconsin in 1951, 1952, and 1953, and who taught near the city of Madison, composed the sample. The significant conclusions found between the two groups of teachers seem to indicate that a pattern of measures of preservice achievement, temperament, and personality will differentiate good teachers from average teachers as defined by the three criterion estimates.

Good teachers appear to be characterized as liking a rapid pace rather than a slow and deliberate one; they may be further characterized for quickness of action, production, and efficiency. Good teachers appear to be higher academically in terms of both the professional and the major teaching field grade point average than are average teachers. Good teachers seem to be more flexible in numerical abilities than average teachers.

A relationship between teaching success as measured by a weighted composite criterion and a linar combination of measures of preservice achievement, temperament, and personality seems indicated. The relationship probably cannot be considered predictive of teaching success, except in a limited time sense.—*D. B. Van Dalen.*

59. National Education Association, Research Division. Salaries paid and salary practices in universities, colleges, and junior colleges, 1955-56. *Research Bulletin*, **34**: 3 (Oct. 1956).

A representative picture of the salary situation in 1955-56 in every type of institution and geographic region of the nation has been prepared. Nine hundred eighty-nine institutions (71.9%) asked to participate submitted reports before tabulations were started. Tabulations were made to show specific salaries paid to: (a) instructional personnel, by rank, for nine months; and (b) administrative personnel, by title, for 12 months.

For all types of institutions and in all regions the median salary for each rank was: professor, $7076; associate professor, $5731; assistant professor, $4921; and, instructor, $4087. Median salaries for administrative officers are: president, $11,314; vice-president, $10,467; dean of college, $7495; dean of students, $7090; business manager, $6682; director of athletics, $6335; head football coach, $5664; head librarian, $5437; registrar, $5230; and dean of women, $5200. Deans of professional schools had a median salary of $10,416 and ranged in medians from high to low as follows: medicine, dentistry, architecture, law, engineering, arts and sciences, extension, education, business, and graduate.

Salaries were shown to vary widely by type of institution and geographic region. Medians for type of institutions are: municipal universities, $6435; state universities, $5649; nonpublic universities, $5585; public junior college, $5470; land-grant colleges, $5458; teachers colleges, $5401; state colleges, $4992; nonpublic colleges over 1000 enrollment, $4756; nonpublic colleges of 500-999 enrollment, $4411; small nonpublic colleges, $4081; and nonpublic junior colleges, $3613. The Far West had the highest regional median salary. In order, other regions are: Middle Atlantic, Middle, New England, Southwest, Northwest, and Southeast.

It was noted that: (a) top salaries are found in both public and nonpublic institutions; (b) some of the better salaries are in regions in which the general salary structure is not too strong; (c) about two-thirds of the institutions try to keep salary schedules, but in searching for replacements and additions approximately one-fifth of the institutions have resorted to higher rank, higher salaries than scheduled for rank, or both; and (d) more information about the compensation, qualifications, and availability of part-time teachers is needed to more nearly complete the report on the present situation.—*Frances Z. Cumbee.*

Growth and Development

60. Deming, Jean. Application of the gompertz curve to the observed patterns of growth in length of 48 individual boys and girls during the adolescent cycle of growth. *Human Biology*, **29**: 1: 83-122 (Feb. 1957).

The Gompertz equation was fitted to observed length during the adolescent growth cycle of 48 individual boys and girls. Significant sex differences were found in the value of the constants K and *b*; in the level of the lower and upper asymptotes of the curve; in the timing of the point of maximum rate of growth; in timing of both points of inflection of the first derivative curve; in the timing of certain physiological events; and in the body build index of these individuals.

Within each sex significant correlations between several of the constants and asymptotes of the curve; between the timing of the point of the maximum rate of growth and timing of physiological events, such as secondary sex development; between the timing of the point of maximum rate of growth and the maximum rate that is attained; and

between timing of the point of maximum rate of growth and magnitude of the total gain in length during the adolescent cycle.

No significant correlation was found between the timing of the point of maximum rate of growth and the adult length attained by the individual and very little evidence of correlation between timing of the point maximum rate of growth and length of the individual at age eight years. A comparison of nude photographs with the growth pattern index 100b/K suggests a relationship between the value of this index and body build. No correlation was found between the body build index and timing of the point of maximum rate of growth.—*D. B. Van Dalen.*

61. GARN, S. M. Research in human growth. *Human Biology*, **29**: 1: 1-11 (Feb. 1957).

Research in human growth has attained a considerable age, and with some degree of maturity. The basic knowledges of the mechanisms and processes of growth in man are still not well understood. The writer finds that studies in human growth are being increasingly problem-oriented, theory-conscious, and biologically relevant. The writer evaluates the present status of growth research and suggests the new developments necessary to the understanding of why individuals grow and why they grow as they do. —*D. B. Van Dalen.*

62. HAMMOND, W. H. Constancy of physical types as determined by factorial analysis. *Human Biology*, **29**: 1: 40-61 (Feb. 1957).

Factor analysis of body measurements for infants from birth to five years have shown that length, girth, and breadth types similar to those found in children of school ages can be distinguished uniformly throughout the age range. In this study, the consistency of the individual type values was assessed over an interval of 3-5 years at various age levels. The type consistency is low in infancy and increases throughout the school ages largely because the variance of the second measurements in older children.

Factor analysis of growth increments showed a distinction into relatively greater length, girth, or breadth development similar to the types of attained measurements, but the type growth was less important than general growth and showed little consistency from one period to another. Within the same social and nutritional levels, the types growth did not appear to be related to the physical type.—*D. B. Van Dalen.*

63. KORNFIELD, WERNER. Typical and atypical changes in the soft tissue distribution during childhood. *Human Biology*, **29**: 1: 62-81 (Feb. 1957).

General anthropometric examination of the skinfold measurements on chest, abdomen, and back, and measurements of the compressible soft tissue on the cheeks were made on healthy white children living in metropolitan and suburban New Jersey from predominantly middle class families largely of Jewish descent. The mean values for the soft tissue masses in all four regions increase rapidly during the first 6 months of life for both sexes. The mean values for the cheeks stay high until about 18 months and decrease slowly thereafter. Mean values for chest decrease slight at the end of infancy, stay low from 1-5 years, then increase to reach the highest values in boys at 11-13 years, in girls at 9-14 years. After 14 years, mean values decrease in both sexes. Mean values for abdomen stay low in boys from 1-9 years, in girls from 1-7 years, after which period an increase takes place faster in girls, slower and less markedly in boys. Changes in the soft tissue masses on the back are similar to those on the abdomen but less pronounced.—*D. B. Van Dalen.*

Psychology

64. GUILFORD, J. P., and WAYNE S. ZIMMERMAN. Fourteen dimensions of temperament. *Psychological Monographs*, **70**: 10 (1956).

Because of two analyses by Lovell and Thurstone, some doubt had been cast on the existence of 13 factors supposedly measured by the Guilford-Martin personality inven-

tories. The present study was a re-examination of the evidence for and against the existence of these factors. Lovell's basic data was used. Intercorrelated variables were part scores rather than total scores as in Lovell's study. Seventy variables were analyzed; three short tests from items scored for each of the 13 hypothesized factors (69 items), and a sex membership variable.

Eighteen centroid factors were extracted. The axes were rotated orthogonally. At least 14 factors were needed to account for the intercorrelations. Thirteen of the factors could be interpreted as being almost the same as hypothesized, although interpretations were modified slightly. The 14 factors were identified as: G—General activity, A—Ascendance vs. submission, M—Masculinity vs. Femininity, I—Confidence vs. inferiority feelings, N—Calmness, composure vs. nervousness, S—Sociability, T—Reflectiveness, D—Depression, C—Emotionality, R—Restraint vs. rhathymia, O—Objectivity, Ag—Agreeableness, Co—Co-operativeness, tolerance, and the 14th—perhaps emotional instability.—*Frances Z. Cumbee.*

Physiology

65. Cherniack, R. M., and D. P. Snidal. The effect of obstruction to breathing on the ventilatory response to CO_2. *The Journal of Clinical Investigation,* **35:** 1286-90 (Nov. 1956).

Six normal subjects and 24 emphysematous patients were tested. Vital capacity and maximum breathing capacity were measured along with responses to 7% CO_2. The results showed that airway obstruction of normal subjects resulted in breathing capacity falling and a decrease in ventilatory response to CO_2. The maximum ventilator response to CO_2 was lower in the emphysematous subjects compared to normal subjects, but little difference was found between the emphysematous and the normal subjects with artificial airway obstruction. The indication is that reduced ventilatory capacity may play a large part in the diminished response to CO_2 found in patients with pulmonary emphysema.—*Michael.*

66. Jongbloed, J., *et al.* A heart function test with continuous registration of oxygen consumption and carbon dioxide production. *Circulation,* **15:** 54-63 (Jan. 1957).

A heart function test is described using an apparatus measuring O_2 and CO_2. Normal and cardiac responses are given. A "function cardiogram" was made using a diaferometer measuring O_2 and CO_2 during rest and work on a bicycle or step amounting to 50 or 60 watts. The indication is that the test will differentiate, in a few minutes, cardiac cases.—*Michael.*

67. Keys, Ancel, *et al.* Physical activity and the diet in populations differing in serum cholesterol. *Journal of Clinical Investigation,* **35:** 1173-1180 (Oct. 1956).

Total serum cholesterol data were studied on samples of men classified by age, activity, and place of living (Minnesota, Malmo, Sweden, Bologna, Naples, Sardinia, South Africa). Differences in cholesterol of different dietary groups are not related to physical activity alone. Within some populations, men in heavy work consume less fats, indicating diet relationship to physical activity. The habitual diet, especially fat, has more influence on total cholesterol than physical activity per se.—*Michael.*

68. Moses, Leon, *et al.* Psychogenic factors in essential hypertension. *Psychosomatic Medicine,* **18:** 471-483 (Nov.-Dec. 1956).

Ten selected samples were used from a hypertensive population. They were given ballistocardiograph tests, blood pressure, and pulse rate tests resting once a week during a period when therapeutic sessions are given. The results showed rage and resentment are psychic concomitants of excessive blood pressure measurements of 160-200/100-130 mm, and related to increased peripheral resistance with normal stroke volume and heart rate. When the anxiety components were more overtly expressed, the minor blood pres-

sures of 140-160/90-100 mm were related to increased stroke volume and heart rate and a normal peripheral resistance.—*Michael.*

69. Norris, F. H., Jr., E. L. Gasteiger, and P. O. Chatfield. An electromyographic study of induced and spontaneous muscle cramps. *Electroencephalography and Clinical Neurophysiology*, **9**: 139-147 (Feb. 1957).

Microelectrodes were imbedded in the muscles of normal subjects and in patients who suffered from spontaneous cramps. Cramps were induced by passive shortening and then maximal contractions. The effect of reflexes and various techniques were studied to determine the part the CNS plays in cramps in skeletal muscles.

Results showed stretching to be an effective means of eliminating most cramps. Motor unit activity was demonstrated by action potentials. The reflex maneuvers led the authors to believe that the motor activity in cramps originated in the CNS.—*C. Etta Walters.*

70. Pearl, D. C., L. D. Carlson, and W. W. Sherwood. Mechanism of oxygen deficit. *Proc. Soc. Exp. Biol. and Med.*, **92**: 277-281 (1956).

Using *in vitro* preparations of dog muscle, determinations were made of high energy organic phosphate, lactate, and oxygen uptake during exercise and recovery. Muscle blood flow and oxygen tensions were also observed. It was found that high-energy phosphate was depleted during exercise, resulting in accumulation of "phosphate acceptor" which is the equivalent of the "oxidizable substrate" in the Henry explanation of alactic debt. The rate of oxygen consumption was controlled by the rate of "phosphate acceptor" accumulation. Considerable lactic acid appeared in the muscle even though the amount of work was not large. "It seems reasonable to suggest that lactic acid is formed in the muscle at any level of work."—*F. Henry.*

71. Von Döbeln, Wilhelm. Maximal oxygen intake, body size, and total hemoglobin in normal man. *Acta Physiol. Scand.*, **38**: 193-199 (1956).

The author correlated maximal energy output of humans with weight (minus adipose tissue), and with total hemoglobin. He found the maximal energy output may be expected to be a linear function of (weight minus adipose tissue) 2/3. Total amount of hemoglobin in the body is related to body size and thus accounts for the high correlation between total hemoglobin and maximal oxygen intake. When the influence of body weight was eliminated, the partial correlation between total hemoglobin and maximal oxygen intake was 0.25.—*C. Etta Walters.*

Guide to Authors

IN LINE WITH the over-all goal of making Association publications yield the greatest value to the individual and the profession, the following is a guide for the preparation of manuscripts for the *Research Quarterly*, recognizing general techniques employed by research publications.

Article Manuscripts

Manuscripts should be sent to the Editor, AAHPER, 1201 Sixteenth Street, Northwest, Washington 6, D. C., who will see that each one is read by at least three members of the *Research Quarterly* Board of Associate Editors. On the basis of the three reviews, the Editor will advise the author as to the suitability of the paper or the desirability for revision. Papers are not judged by arbitrary standards but on their content of new research results in the field of physical education, health education, and recreation, presented with the greatest brevity compatible with scientific accuracy and clarity (see October 1951 *Quarterly*, pp. 392-4).

Since three members of the Board of Associate Editors review an article, it is requested that three clear copies of the manuscript be submitted in order to facilitate reviewing. A fourth copy of the article should be retained.

Typewritten manuscript should be double-spaced on white paper of ordinary weight and standard size (8½ x 11 inches). A brief abstract of the article, 100 words or less, should be typed double space on a separate sheet. See abstracts at head of *Quarterly* articles for style.

The sheets of manuscript should be kept flat and fastened with clips which can be removed easily. The pages of the typewritten copy should be numbered consecutively in the upper right-hand corner. Paragraphs should be numbered consecutively throughout the manuscript.

Notes and Comments

Notes on minor research and on apparatus, *objective* critical comments, and summaries of status suveys will be printed in the Notes and Comments section. Note that simple status surveys are no longer acceptable as regular *Quarterly* articles, by decision of the Research Council. Such studies will therefore be published in brief form (300-500 words) under Notes and Comments.

Headings

The article should be arranged so as to indicate relative values of heading and subheadings.

Usually four gradations are sufficient: (a) article title, (b) first subhead appearing in boldface aligned left on page (underscored in manuscript with wavy line) (c) second subhead (if necessary) appearing in small caps aligned left on page, (d) third subhead, to appear in italic (underscored in manuscript), not centered, but run in at the beginning of the paragraph or section.

All headings should be typed in lower case with initial capitals, except for (c) above, which should be typed in capital letters.

FOOTNOTES

Footnotes are not to be used for references or literature citations. They are rather used for the purpose of acknowledgment, special explanation, supplementary information, etc. (*See examples below.*)

Type footnotes (if any) on separate sheets, as many footnotes as convenient being written on a sheet. Footnotes should be numbered from 1 up for each article; a corresponding numeral appearing in the text. Asterisks should not be used.

Examples of Footnotes:

[1] This study was made under the direction of Dr. Arthur T. Slater-Hammel in the Research Laboratories, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana.

[2] All measurements of the hand were recorded in centimeters and height was recorded in inches. The hand measurements were taken by Everett and reliability coefficients of above .90 were found for each measurement used in the study.

[3] For their wholehearted co-operation in facilitating collection of the data, special gratitude is extended to Superintendent Clarence Hines and the 1950-51 principals of the Adams, Condon, Edison, Francis Willare, Harris, Howard, Lincoln, River Road, and Whiteaker schools.

Documentation

CITATIONS OF LITERATURE

Citations of literature should be segregated alphabetically by author's last name at the end of each article, under the caption of "REFERENCES." *Do not treat them as footnotes. (See above.)*

The literature citations, listed alphabetically, should be numbered consecutively, their location in the text being indicated by corresponding numbers written in full size and enclosed in parentheses: for example, (1) (2, 3). If there are several references in the text to a citation, the specific pages may be indicated thus: (1, *p. 117*), (1, *pp. 162-3*).

A uniform style should be maintained in writing citations. Do not enclose titles of chapters and articles in quotation marks. Italicize (underscore in manuscript) names of books and periodicals, bulletins, etc. (*See examples below.*)

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Examples of References Appearing at End of Article:

1. American Association for Health, Physical Education, and Recreation. Suggested platforms for health education. *Journal of the American Association for Health-Physical Education-Recreation*, 18:436 (Sept. 1947).
2. American Association of School Administrators. *Health in Schools.* Revised edition. Washington, D. C.: the Association, a department of the National Education Association. pp. 266-7.

3. Deaver, G. G., Exercise and heart disease. *Research Quarterly*, **26**: 24-34, 1939.
4. Ogden, Jean, and Jess Ogden. *Small Communities in Action.* New York: Harper & Brothers, 1946.
5. Potter, John Nicholas. *Physical Fitness of Junior High School Boys.* Unpublished Master's thesis, University of California, Berkeley, 1942.

Tabular Matter

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Mdn = median	r_{bis} = biserial correlation
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n = number of measurements	χ^2 = chi square
σ = standard deviation	F = variance ratio
σ_M = standard error of mean	t = Student (Fisher) t ratio

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